Where the River Begins

An Educator's Guide to the Nisqually River of Mount Rainier National Park

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Where the River Begins is the first in a series of educator's guides for the Nisqually River basin. This guide was a joint project of Mount Rainier National Park and the Nisqually River Education Project (NREP). Additional support was provided by the Washington Department of Ecology's Centennial Clean Water Fund.

NREP is developing a variety of educational materials and trainings for selected sites throughout the Nisqually River basin. These resources will help students develop an understanding and appreciation for this beautiful watershed, and motivate them to wisely manage its unique environmental, economic and cultural resources.

For information on this and other educator's guides, teacher workshops, and the Nisqually River Education Project, contact:

Nisqually River Education Project
Yelm Community Schools
P.O. Box 476
Yelm, WA 98597
(360) 458-6137

Resource Education Specialist
Mount Rainier National Park
Tahoma Woods - Star Route
Ashford, WA 98304
(360) 569-2211 ext. 3313

Where the River Begins

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Where the River Begins

Introduction

The Nisqually River Basin

The Nisqually River flows 78 miles from its source at the Nisqually Glacier on 14,411 foot Mount Rainier to its delta at Puget Sound. The river is a direct link between the summit snows of Washington's highest peak and the marine waters of Puget Sound. The Nisqually is one of the least developed and most pristine major rivers in Washington state. During the course of its journey, the river flows through an amazing variety of habitats – from subalpine meadows and old-growth Douglas-fir forests in Mount Rainier National Park through forested foothills and across lowland prairies to its estuarine reaches and tidal mudflats in Nisqually National Wildlife Refuge.

The river's journey encompasses a great diversity of ecosystems and a broad range of land uses and jurisdictions. The river flows through national and state parks and forests, public and private timberlands, municipal hydropower projects, farmlands, the Nisqually Indian Reservation, Fort Lewis and the Nisqually National Wildlife Refuge. Growing communities complicate management of the basin.

The Nisqually River Council was formed in 1987 as a non-regulatory cooperative group. It is a broad-based organization comprised of public agencies, businesses, local governments and private citizens who are committed to the protection and enhancement of the Nisqually River and its basin. The Council is a forum through which people work together to manage the watershed as a whole natural system.

The Nisqually River Education Project provides environmental education designed to help students understand the issues and activities that affect the basin; *to explore the Nisqually River basin as a whole system, with particular emphasis on the interrelationship of the basin's environment, cultural history and economic resources.* The overall goal of the program is to foster a sense of stewardship among students within the basin and beyond. The project is facilitated by Yelm Community Schools. Field trip opportunities, a student water quality monitoring network, specialized trainings for teachers, and curricular resources are all offered through the Nisqually River Education Project.

Purpose of *Where the River Begins*

Where the River Begins is an interdisciplinary guide for teachers which can be adapted for a variety of grade levels. This is one of a series of guides written for selected locations in the Nisqually River basin as part of the Nisqually River Education Project. The series provides an opportunity to develop an understanding of the culture, economy, natural history, and land use of the basin, as well as the importance of each in our society today. This guide encompasses the headwaters of the Nisqually River in Mount Rainier National Park focusing on mountain life zones, old-growth forests, glacial rivers, glaciers, land use, and the national park idea.

Goals of This Guide

In 1990 the Washington State School Board directed public schools to incorporate environmental education into all appropriate subject areas. The Superintendent of Public Instruction's (SPI) Environmental Education Guidelines for Washington schools offer four goals that provide for students to:

1) Develop knowledge of the components of the environment and their interactions;
2) Value the environment as the basis of our physical lives, economy, and emotional well-being;
3) Apply personal decision-making skills to enhance environmental quality; and
4) Develop and utilize the knowledge and skills necessary for cooperative action on behalf of the environment.

Where the River Begins helps educators to meet these statewide goals, and also seeks to:

1) Assist teachers in preparing and leading students on a field trip to Mount Rainier National Park to study the Nisqually River from its source at the Nisqually Glacier and the old-growth forest within its watershed;
2) Increase students' knowledge and sense of stewardship for the Nisqually River basin, including the Nisqually Glacier in Mount Rainier National Park, and the living organisms dependent on this system;
3) Increase students' awareness and understanding of the National Park Service's role in preserving and protecting watersheds and other natural systems; and
4) Foster in students a feeling of responsibility for protecting and wisely using Mount Rainier and other national parks.

Educational Concepts

Life Zones

1) Mountain ecosystem types change dramatically according to elevation, climate and soil conditions.

Old-Growth Forest

1) The old-growth forest and the Nisqually River in Mount Rainier National Park are interdependent.
2) Mount Rainier National Park contains outstanding examples of the native flora and fauna of the Cascade Mountains.
3) The old-growth forest ecosystem which encircles Mount Rainier is representative of what much of the Nisqually River basin was once like.

Glacial Rivers

1) Rivers which are fed by active glaciers, such as the Nisqually, flow in braided channels, carry glacial flour, and have rounded rock stream beds.

Glaciers

1) The Nisqually Glacier is at the head of the Nisqually River, and is a primary source its waters.
2) A glacier is a moving "river" of ice formed by great amounts of snow accumulating over many years, compressing into ice, and then moving downhill under its own weight.
3) Mount Rainier's height and location influence the high amounts of snowfall on the mountain, which in turn feeds the glaciers.
4) A glacier, such as the Nisqually, moves at different rates and erodes the landscape as it moves.

Land Use and the National Park Idea

1) Mount Rainier and its surrounding watersheds have attracted people and influenced their cultures throughout the centuries.
2) One way of preserving watersheds is by including them in national parks.
3) National parks are managed to preserve the natural resources and provide for the enjoyment of these resources. This is in contrast to national forests and other areas which may practice multiple use of natural resource lands.
4) We are all responsible for protecting the natural resources of Mount Rainier National Park.

Mission: National Park Service and Mount Rainier National Park

"To conserve the scenery and the natural and historic objects, and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

– National Park Service Organic Act 1916

"...dedicated and set apart as a public park...for the benefit and enjoyment of the people; ...provide for the preservation from injury or spoliation of all timber, mineral deposits, natural curiosities, or wonders within said park, and their retention in their natural condition."

– Legislation Establishing Mount Rainier National Park, 1899

"The purpose of the park is to protect, preserve, and interpret the natural, scenic, and historical resources in Mount Rainier National Park. Mount Rainier is a classic example of a dormant composite volcano, with the largest single peak glacial system in the contiguous United States. The park also contains outstanding examples of the native flora and fauna of the Cascade Mountains."

– Mount Rainier National Park Statement for Management

Matrix of Educational Concepts by Activity

	Life Zones	Old-Growth Forest	Glacial Rivers	Glaciers	Land Use
Pre-Trip					
Go Take a Hike!					1
Outdoor Manners					4
Mount Rainier Map Mania					2
Trees to Tundra	1				
Old-Growth Vocabulary		2			
Old-Growth Web of Life		1,2			
An Imaginary Hike		2,3			
How Wet are Your Woods?	1	1			
Forest Study Plot	1				
Braid a River			1		
Run River Run			1		
Mountain on the Way to the Sea			1	1	
Shake, Rattle and Roll			1		
Film Fest (Fire and Ice)				2,3,4	
Film Fest (From Summit to Sound)				1	1,2,4
Making a Glacier				2,4	
Glacier Vocabulary				2,4	
Glaciers of Mount Rainier				1,3	
Galloping Glaciers				2,4	
Glacier on the Move				4	
Insulating Ice				2,3	
Giant Ice Scrapers				4	
Nature's Sculptors				4	
Forward or Reverse?				1,2,3,4	
Mapping the Snout				1,2,4	
Yoke-Ull-What?!				4	
Mountain Readings					1,2,4
Who Owns the Forests?					2,3
Managing the Land					2,3
National Park Resources: What If We Run Out?					2,4
On-Site					
Glacial River Study			1		
Young Forest Study Plot	1	1,2			
Breathing Leaves / How Wet Are Your Woods?	1	1			
Old-Growth Forest Study Plot	1	2,3			
Paradise Activities	1			1,2,3,4	1,4
Post-Trip					
Log Book Follow-Up	1	1,2,3	1	1,2,3,4	1,2,3,4
Individual and Group Sharing	1	1,2,3	1	1,2,3,4	1,2,3,4
Simulation Game / Class Debate					1,2,3,4
Life Zone Mural	1				
Creative Writing	1	1,2,3	1	1,2,3,4	1,2,3,4
Sharing the Joy of Song	1	1,2,3	1	1,2,3,4	1,2,3,4
Web of Life Game		1,2			1,4
Graphing the Drainage		1		1	
Nisqually Watershed: Past and Present					1,2,4

How to Use This Guide

Where the River Begins contains three sections of materials for teachers and students (Pre-Trip Activities, On-Site Activities, and Post-Trip Activities) plus a Resource section.

PRE-TRIP materials consist of teacher lesson plans, including background information and student worksheets addressing each of the guide's educational concepts. The student worksheets are printed on white paper for easy reproduction. In order to make a field trip to Mount Rainier National Park as worthwhile as possible, classes should prepare for their visit by reviewing this information. There are more lessons included in this section than most classrooms will have time to complete. Please choose the activities that best support your focus of study, rather than trying to do all of them.

ON-SITE activities are designed for classes who are visiting the park on a self-guided field trip. These activities have been developed to give direction and focus to the self-guided visit, enabling the classes to learn first-hand the important concepts of this guide. The On-Site section is divided into two parts: the teacher's background information and lesson plans, and the Student Log Book. The Student Log Books are designed to be copied for each student and used on the field trip to Mount Rainier.

POST-TRIP activities provide closure for classes following their visit to Mount Rainier. In order for students to understand and retain what they have learned on the field trip, it is important to provide follow-up lessons for review and further study.

RESOURCES provided with this guide include a trip fee waiver form, a glossary of special terminology, a bibliography of related educational material and other reference books, and supplementary Mount Rainier background information.

Although this guide is geared toward the upper elementary grades, many of the activities can be easily adapted for higher or lower grade levels. As the teacher, you know your students and will know best how to tailor the activities to suit their abilities. Ideally, this curriculum includes a field trip to Mount Rainier, yet the majority of the activities are effective even if a trip to the park is not possible.

Field Trip Logistics

Fee Waiver

An entrance fee is required of persons entering the park. However, your trip to Mount Rainier National Park may qualify for a fee waiver under educational study. This fee waiver is issued only in advance of your trip. To obtain a fee waiver for your class, photocopy and complete the "Request for Fee Waiver for Educational Study" form located after the bibliography in the Resources section of this guide. Send it to Mount Rainier National Park for approval **at least two weeks in advance** of your trip. Your approved request will be returned to you. This form **must** be presented to the entrance staff. They are not permitted to authorize fee waivers at the entrance station and failure to have an approved fee waiver with you could result in payment of the standard entrance fee for each person in your group.

Mail your fee waiver request to: *Chief Ranger, Mount Rainier National Park*
Tahoma Woods - Star Route
Ashford, WA 98304

Facilities

Mount Rainier National Park is located on the west slope of the Cascade Range, approximately 65 miles southeast of the Seattle/Tacoma metropolitan area and approximately 65 miles west of Yakima. At Elbe, Highway 706 leads to the Nisqually Entrance, the southwest entrance of the national park. This entrance is open year-round and leads to Longmire and Paradise.

Public facilities open daily year-round are located at Sunshine Point Campground and Longmire. Longmire facilities include the Museum and the National Park Inn (food, lodging, and gifts). The Cougar Rock Campground is open from late May to October. The Henry M. Jackson Memorial Visitor Center at Paradise is open daily from early May to early October, and on weekends and holidays only the rest of the year.

Public restrooms are open all year at Sunshine Point Campground, Kautz Creek, Longmire, and Paradise. Picnic facilities are located at Sunshine Point, Kautz Creek, Longmire, and Paradise. Food and drinks are not allowed in the Longmire Museum or on the exhibit floors and enclosed patio of the Jackson Memorial Visitor Center.

Other areas of the park, such as Ohanapecosh and Sunrise, are open seasonally and offer a number of visitor services. Please refer to the park map and guide for details.

Mount Rainier National Park is fortunate to have a park-wide recycling program. Look for the green recycling containers and help our program and our environment by sorting your trash into the proper bin.

Park Rules

The National Park Service is entrusted with the responsibility of protecting and managing the resources of Mount Rainier National Park. Everything within Mount Rainier National Park is protected, therefore **the collecting and gathering of anything in the park is prohibited**. This includes everything from rocks and cones, to flowers and leaves. Please help your students to understand the importance of observing the things here in the park, but leaving them for others to experience and enjoy.

When walking in heavily visited subalpine areas, such as Paradise, it is important to stay on the maintained trails and not cut across the meadows. These flower meadows are fragile and have a very short growing season. With two million people visiting the park every year, each footstep can cause irreparable damage to the plants growing in the meadows.

Seeing wild animals is an exciting part of a visit to Mount Rainier National Park. We ask that you observe but do not feed the wildlife, which are adversely affected by well-meaning handouts. Some animals require specific foods to prepare themselves for the long winters – our food does not supply the right fats and protein for these animals. In addition, wild animals do bite and may carry diseases. Feeding animals can lead to injuries to people, as well as to the animals. Animals may congregate in unnaturally high populations where people are feeding them, resulting in fatal epidemics sweeping through the population. Remember, the animals at Mount Rainier are wild and should remain that way!

Safety Concerns

The safety of your students is most important! The area you visit may not be familiar to you or your students and special attention needs to be paid to potential hazards.

- If you are near any of the streams in the park, remember the water is cold and swift and can be very dangerous. The rocks can be wet and slippery. Use caution, and please, **no** running near stream banks.
- Proper dress for the weather and location is important for the student's safety. Temperatures in the park can be much colder than at home or school, so dress warmly, preferably in layers. Be prepared for quickly changing weather conditions and cold, wet, windy weather on your visit; if it is sunny and warm count yourself fortunate.
- Park trails can be steep, slippery, and full of hazards, such as rocks, roots, and fallen branches. Proper footgear is essential for traction, support, and protection.
- Beware of cliffs and steep drop-offs. Stay away from edges!
- The mountain streams of Mount Rainier may look clear and drinkable, but can harbor some nasty disease-causing micro-organisms such as Giardia. Please drink water **only** from treated, piped water systems.
- Do not throw rocks in the park, especially over cliffs or along the rivers. Someone could be injured.

Students must be supervised by an adult at all times while in the park.

Naturalist Staff

If you would like to request a naturalist to meet your group while in the park, contact the Mount Rainier National Park Education Office at (206) 569-2211 ext. 3313 in advance of your trip. Park staff are usually not able to spend the day with your group, but may be available to meet with your students at Longmire to welcome you and present a general overview of the park. In addition, a naturalist can usually be found at the Longmire Museum to answer your questions.

Acknowledgments

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Where the River Begins is available from the Nisqually River Education Project, Yelm Community Schools, P.O. Box 476, Yelm, WA 98597-0476, (360) 458-6137 and the Education Office, Mount Rainier National Park, Tahoma Woods - Star Route, Ashford, WA 98304, (360) 569-2211 ext. 3313.

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Where the River Begins

Pre-Trip Activities

There are many more activities in this section than you will likely need or have time to complete. We suggest that you look through the activities in the area of study in which you are concentrating, and choose those that most closely meet your goals and interests. To help you decide which activities to use when time is limited, we have selected those we feel best illustrate the concepts of *Where the River Begins*.

Safety and Orientation

(These activities are most relevant if your class will be taking a field trip to Mount Rainier National Park.)

Life Zones

Trees to Tundra

Old-Growth Forest

Old-Growth Web of Life
Forest Study Plot (if taking a field trip to Mount Rainier)

Glacial Rivers

Run River Run (if taking a field trip to Mount Rainier)
Mountain on the Way to the Sea

Glaciers

Making a Glacier
Glaciers of Mount Rainier
Galloping Glaciers
Giant Ice Scrapers
Nature's Sculptors
Mapping the Snout (if taking a field trip to Mount Rainier)

Land Use and the National Park Idea

Mountain Readings
Who Owns the Forests?

If you are focusing on only one of the themes in *Where the River Begins*, such as glaciers, you may want to do more of the activities from that particular unit. The pre-trip activities will hopefully reinforce what the students already know as well as motivate them to learn more. They are also designed to help you prepare your class for a trip to Mount Rainier National Park.

Safety and Orientation

"Give me a summer and a bunch of matches and a sack of meal and I will climb every mountain in the region." – *John Muir*

Go Take a Hike!

Subjects
health
physical education

Skills
compare/contrast
listing
analysis
valuing
discussion

Materials
• various articles of clothing
• *Ten Essentials* list*

** provided*

Vocabulary
hypothermia

Learner Outcome

Students will understand the relationship between trip preparation and personal safety.

Background

Weather can change quickly at Mount Rainier! A chilly morning may become warm and sunny by midday, then turn into rain in the afternoon. Many people have been caught unprepared by the mountain's unpredictable weather patterns.

Layer System

One way to stay warm and dry is to practice the layer system of clothing. Essentially, this system involves several thin layers of insulation, trapping warm, dead air between them, rather than a single thick layer like a heavy parka or coat. By combining layers of wool, cotton, polyester and nylon, one can obtain the most warmth for the least weight and also maintain better heat control. An example of the layering system of clothing follows:

Inner Layer
cotton shirt, T-shirt (warm weather), polyester (cold)

Second Layer
medium weight wool shirt

Third Layer
medium weight sweater or second wool shirt

Outer Layer
nylon wind breaker, pile jacket, rain gear,
wool or polypropylene hat, mittens

In the mountains, every part of the body must be insulated from the cold or storms. The main centers for controlling our human thermostats are the torso and the head ("If your feet are cold, put on a hat."). If the head and torso are cold, the whole body may start shivering; if they are warm, the rest of the body will be more comfortable.

Protect yourself against possible cold, wet and windy conditions and hypothermia, a life-threatening lowering of the inner body temperature. Hypothermia can occur when outside temperatures are above freezing. Be alert for the symptoms – uncontrolled shivering, difficulty speaking, stumbling and poor coordination, weakness and confusion – and prevent further heat loss any way possible.

Ten Essentials

The Ten Essentials is a list of important items for those hiking in less heavily used areas. How many of these items someone carries depends on the length of the hike, the type of terrain/environment, and the size of the group. Together they ensure a safer, more comfortable trip.

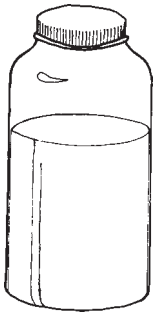
1) *Extra Clothing* – either wool or other warm-when-wet fabric; rain gear
2) *Extra Food and Water* – enough for a possible emergency
3) *Sun Protection/Sunglasses* – for open alpine areas and snow
4) *Knife* – many uses: eating, first aid, fire starting
5) *Fire Starter* – e.g. fire ribbons, candle stubs; for emergency fires (note: fires are not permitted at Mount Rainier outside campgrounds unless an emergency)
6) *Matches* – waterproofed
7) *First Aid Kit* – include bandages, gauze pads, adhesive tape, mole skin, aspirin, needle and first aid manual (e.g. *Mountaineering First Aid* by Dick Mitchell)
8) *Flashlight* – make sure your batteries are good
9) *Map* – know how to use it!
10) *Compass* – companion to the map

Procedure

Explain to the class the importance of dressing appropriately for the weather. Demonstrate the principle of layered clothing by adding on layers of clothes in front of the class and discussing each one. Give alternatives for each layer and review the advantages and disadvantages of different types of fabric.

Ask them what they think is important to carry on a hike in the wilderness. Make their own list, then show them the Ten Essentials list and discuss the purpose of each item.

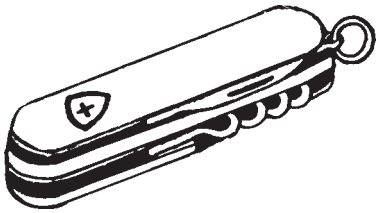
THE TEN ESSENTIALS



1) EXTRA CLOTHING

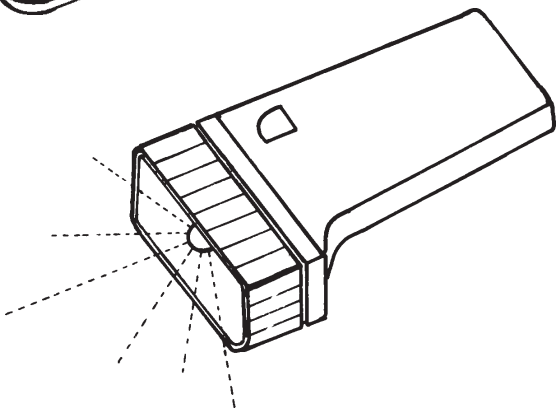
2) EXTRA FOOD & WATER

3) SUN PROTECTION & SUNGLASSES



4) KNIFE

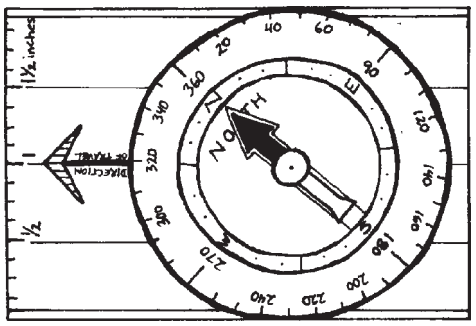
5) FIRE STARTER



6) MATCHES

7) FIRST AID KIT

8) FLASHLIGHT



9) MAP

10) COMPASS

Outdoor Manners

Subjects
art
social studies
language arts

Skills
drawing
discussion
valuing
creating

Materials
- large-sized paper or tagboard
- drawing material
- *Mount Rainier Official Map and Guide* (optional)*
- stencils (optional)

** provided*

Learner Outcome

Students will be able to recommend appropriate actions in the outdoors, especially when visiting national parks.

Procedure

1) Have a discussion with your students on the effects our actions can have on the outdoor environment. Make a student-generated list on the chalkboard of the types of outdoor behaviors they recommend while visiting Mount Rainier National Park. Some examples are:
   - Carry out all your trash and if possible, pick up any litter left by others.
   - Respect all wildlife and do not harass any animal.
   - Stay on the trail unless instructed otherwise.
   - Plants are protected and not to be picked, carved or harmed.
   - Loud noises/voices can scare off wildlife and disturb other hikers.
   - Cutting switchbacks and taking shortcuts can cause erosion and damage resources.

   For more ideas refer to *Mount Rainier's Official Map and Guide* (a copy is included with this guide).

2) Have each student choose one behavior statement, write the statement on a posterboard, and draw a picture to illustrate it. Display posters in classroom or school.

Variations

Working in small groups, each person in the group illustrates and captions one of the "rules". Combine to make a group book. Or transfer students' line drawings to stencils and duplicate them to create an "Outdoor Manners Coloring Book" to share with other classes in your school.

(from "Outdoor Manners Coloring Book" in *Project Learning Tree, Activity Guide K-6*)

Mount Rainier Map Mania

Subjects
geography
math

Skills
observation
map reading
interpreting
measuring

Materials

- *Mount Rainier National Park Official Map and Guide* (one per student/group)*
- *Map Mania* worksheet*
- ruler and string
- *Nisqually River Basin Map* (optional)*

** provided*

Learner Outcome

Students will become familiar with reading a map and with the layout and facilities of Mount Rainier National Park.

Procedure

Contact the national park ahead of time to receive free copies of the park's official map and guide (Mount Rainier National Park, Tahoma Woods - Star Route, Ashford, WA 98304, (206) 569-2211 ext. 2304). One copy is included in the Resource section. Distribute worksheets along with the park maps. This activity can be done as a group or individual project.

Extension

Outline the Nisqually watershed located within Mount Rainier National Park on the park map. You may want to refer to the Nisqually River Basin Map to help you with this.

Answers to Map Mania Questions

1) 3/4 inch equals 1 mile; 1.25 cm equals 1 kilometer
2) In the upper left hand corner
3) 3: Carbon River, Nisqually, and White River
4) Ranger station, picnic area, lodging, restaurant, groceries, and an interpretive trail; symbols
5) Ranger station, restaurant, interpretive trail, picnic area, lodging
6) Paved
7) Yes, unpaved
8) State highways 410 and 123
9) Answers will vary – Lake George, Reflection Lakes, Louise Lake, Bench and Snow Lakes, Blue Lake are a few.
10) Mowich Lake
11) White in color with names in blue
12) Longmire – 2,700ft/824m; Paradise – 5,400ft/1647m; Camp Muir – 10,188ft/3105m
13) Columbia Crest
14) 14,410 ft/4394 m
15) Cowlitz
16) Dotted lines
17) Pacific Crest Trail
18) Wenatchee National Forest; William O. Douglas Wilderness
19) 6 miles; 30 miles

MOUNT RAINIER MAP MANIA

Use the map of Mount Rainier National Park to help you answer the following questions.

1) What is the scale in miles? _____ in kilometers? _____

2) Where is the compass direction on the map located? _____

3) How many entrances with ranger stations are in the park?_____

   Name them: _____

   _____

4) What services can you find at Longmire? _____

   _____

   How can you tell?_____

5) What services can you find at Paradise?_____

   _____

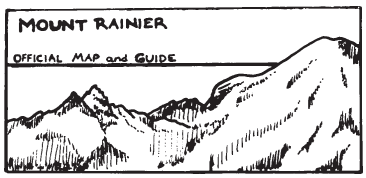
6) What type of road runs between Nisqually and Longmire?

   _____

7) Are there other types of roads in the park? _____

   What type? _____

MOUNT RAINIER MAP MANIA



8) Which state highways are in the park?

_____

9) Name two lakes on the south side of the park: _____

_____

10) What is the biggest lake in the park? _____

11) How are glaciers shown on the map? _____

12) What is the elevation of Longmire? _____ of Paradise? _____

of Camp Muir? _____

13) What is the name of the highest point on Mount Rainier? _____

14) How high is Mount Rainier in feet? _____ in meters?_____

15) Which river flows through Box Canyon? _____

16) How are trails shown on the map?_____

17) What trail runs north to south along the eastern boundary of the park?

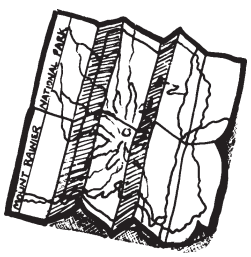
_____

18) What land is found east of the park? _____

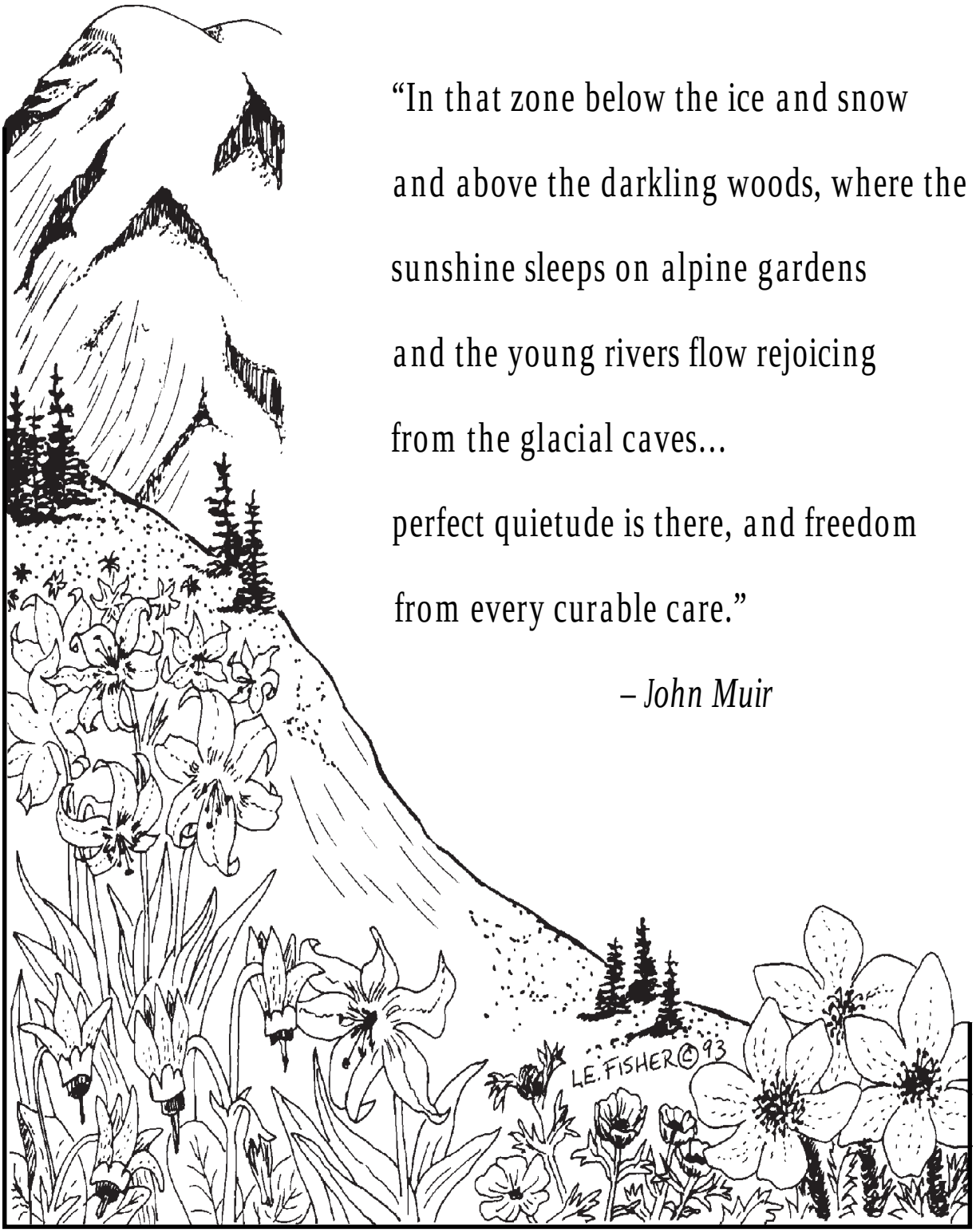
19) Use your ruler and string to answer the following:

How far is it by road from the Nisqually entrance to Longmire? _____

How far is it by road from the Stevens Canyon Entrance to Sunrise? _____



Life Zones



"In that zone below the ice and snow
and above the darkling woods, where the
sunshine sleeps on alpine gardens
and the young rivers flow rejoicing
from the glacial caves...
perfect quietude is there, and freedom
from every curable care."

– John Muir

Trees to Tundra

Subjects
communications
science
art
geography

Skills
compare/contrast
oral presentation
drawing
research

Materials
- paper and drawing material
- field guides
- life zone checklists*
- plant and animal pictures

** provided in On-Site section*

Vocabulary
temperate
life zone
conifer
canopy
understory
Douglas-fir
western red cedar
western hemlock
subalpine
alpine

Learner Outcome

Students will be able to describe the four major life zones found at Mount Rainier National Park, and identify some of the plants and animals which inhabit each zone.

Background

The elevation of Mount Rainier spans from 1,500 feet at the base to 14,411 feet at its summit. For every 1,000 foot increase in these maritime mountains, the temperature drops about 1.5° Fahrenheit. You can go from a temperate world of moderate temperatures to the Arctic tundra by simply climbing the mountain! This wide elevation range supports a corresponding variation in vegetation and wildlife. Belts of similar vegetation are referred to as life zones. There are four main life zones in the park, though no sharp boundaries separate them and species overlap. Following is a brief description of each zone.

Lowland Forest

Below 900 m (3000 ft.)

- Characterized by mature forests of large, old conifers, both living and dead
- Very little sunlight reaches the forest floor; thick covering of smaller plants such as mosses, ferns, fungi and flowers
- Dense, multi-layered canopy; sparse understory of shade tolerant trees; fair number of shrubs

Trees: Douglas-fir, western red cedar, western hemlock, grand fir
Shrubs: vine maple, devil's club, Oregon grape, salal
Birds: owls, woodpeckers, thrushes, jays
Mammals: bats, rodents, deer, hares, raccoons, mountain lions
Other: snakes, banana slugs

Pacific Silver Fir

900-1500 m (3000-4900 ft.)

- More open areas and smaller trees than in the lower forest
- Sparser understory; heavier shrub layer
- More barren forest floor (less moss)

Trees: Pacific silver fir, noble fir, mountain hemlock, Alaska yellow cedar
Understory: huckleberries, wildflowers e.g. bunchberry, pipsissewa, Cascades azalea
Mammals: elk, black bear, pika

Subalpine
1500-2100m (4900-6800 ft.)

- Areas of low vegetation mixed with clumps of trees
- Severe climate and a short growing season results in little annual woody growth
- Trees are small and narrow; branches flex to shed heavy snows

Trees: subalpine fir, Pacific silver fir, mountain hemlock, Alaska yellow cedar
Flowers: lupines, avalanche lilies, paintbrush, bistort, heather, etc.
Mammals: elk, deer, black bear, mountain goats, marmots
Birds: blue grouse, gray jay, Clark's nutcracker

Alpine
2100-4394 m (6800-14,411 ft.)

- Also known as tundra
- A harsh, rocky landscape above treeline with uniquely adapted, hardy plants
- Freezing summer temperatures and gale force winds
- Perpetual ice and snow found above fellfields (stone "fields", less than half covered with plants)

Plants: heather, lupine, algae, lichens
Mammals: deer mice, voles, mountain goats
Birds: rosy finches, ravens
Other: spiders, insects

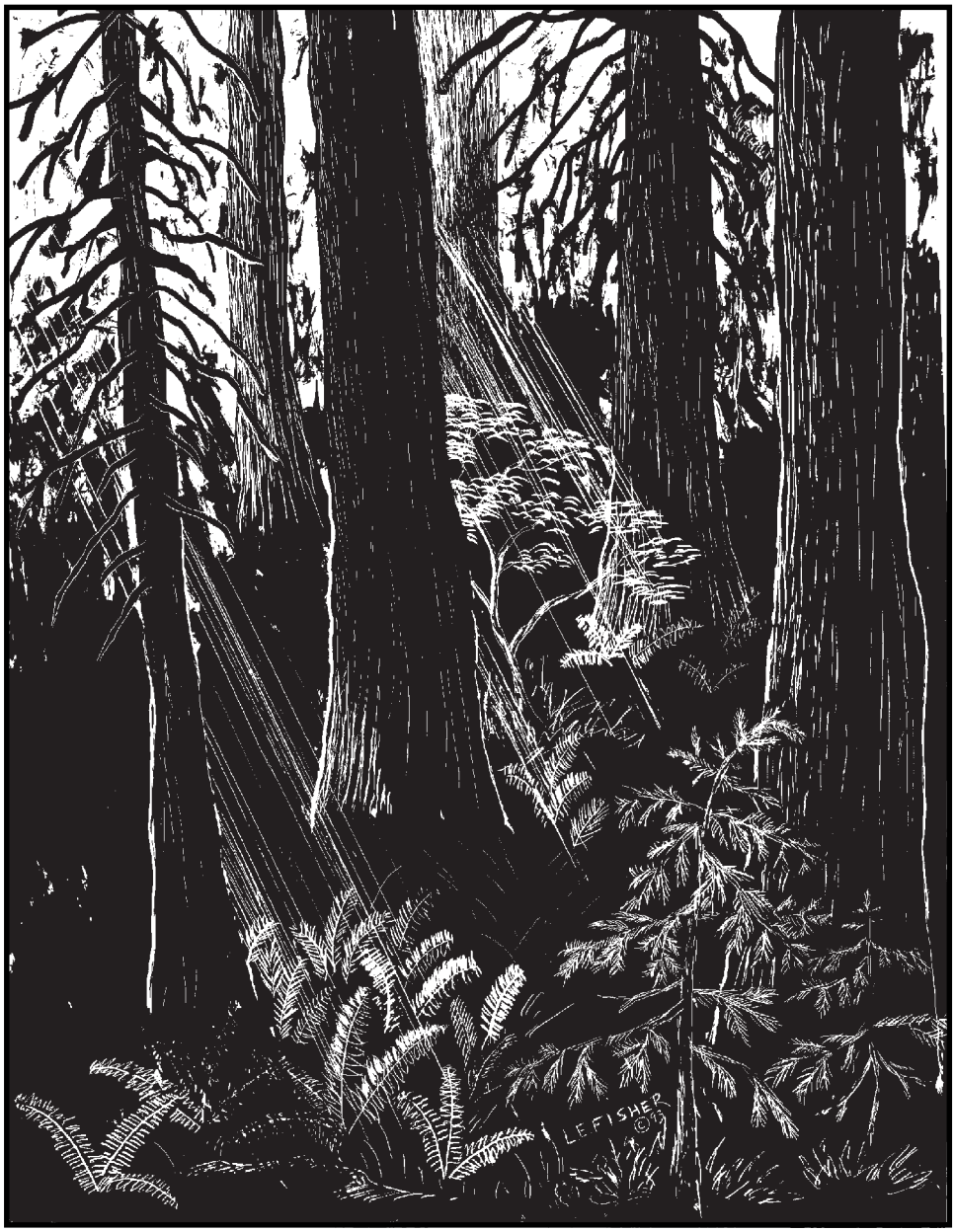
Procedure

Review the different life zones of the western Cascades with students. Include plants, animals and physical factors. Divide class into four groups and have each group research one of the life zones. Give each group a copy of the teacher's background for their life zone. After completing research have each group draw a large picture of their life zone, including the various plants and animals found there. Groups then give presentations to the class. Label the four drawings and display them on the wall, starting with the lowland forest picture on the bottom and ending with the alpine zone on the top.

Extensions

1) Compare the life zones of the Cascade mountains with another mountain range such as the Rockies or the Alps.
2) Using a large, single sheet of paper, make four accordion folds, having each fold representing a different life zone. Illustrate each fold/zone.
3) Indicate on a topographic map or the park brochure where the various life zones are found within the park.
4) Have students keep a checklist of the plants and animals they see in each life zone while on the field trip to Mount Rainier. Checklists are included in the Student Log Book in the On-Site section.

Old-Growth Forest



"The woods arise in shaggy majesty, every light giving tints of exquisite softness to all the wilderness.

Trees ancient-looking abound in damp gullies and on stream-banks, forming the forest primeval...

Here are true Gothic temples with tree-shafts pointed and aspiring." – *John Muir*

Old-Growth Vocabulary

Subjects
language arts
science
art

Skills
sorting
reading
classifying
questioning
illustration

Materials
- vocabulary list
- activity sheets *(Word Search, Match-Up, Cross-word Puzzle)**
- answer sheet*
- picture dictionary: large sheets of paper, drawing material
- guessing game: card or paper for each word; tape, pins or clothes-pins

** provided*

Vocabulary
see list

Learner Outcome

Students will become familiar with new vocabulary words and be able to spell and define twelve of these words.

Old-Growth Forest Vocabulary List

(see Glossary for definitions)

ancient forest	ecosystem	producer
biodiversity	habitat	red tree vole
biomass	indicator species	snag
canopy	lichen	spotted owl
climax forest	marbled murrelet	succession
community	mycorrhizae	transpiration
conifer	nitrogen fixing	understory
decomposer	nurse log	watershed
Douglas-fir	pine marten	western hemlock
		western red cedar

Picture Dictionary

Assign each student one of the old-growth forest vocabulary words. Have them write their word and its meaning on a sheet of paper, then illustrate their word on the same piece of paper. After the students share their word with the class, put all the papers together and make a "picture dictionary".

"What Am I?" Guessing Game

Write each of the vocabulary words on a card or piece of paper. Fasten a card to the back of each student and have each student try to guess what their word is by asking classmates yes or no questions (e.g. Am I an animal? Do I make my own food? Am I alive?). This can be done as a group, having only one student asking the class questions, or as individuals, with all the students mingling and asking each other questions.

Word Search

(see handout)

Match-Up

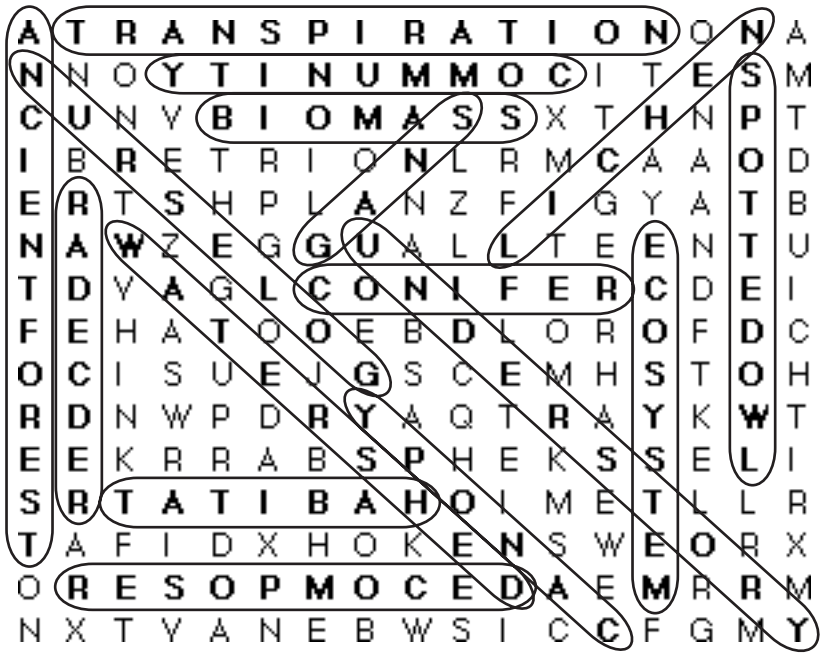
(see handout)

Crossword Puzzle

(see handout)

Forest Vocabulary Answer Page

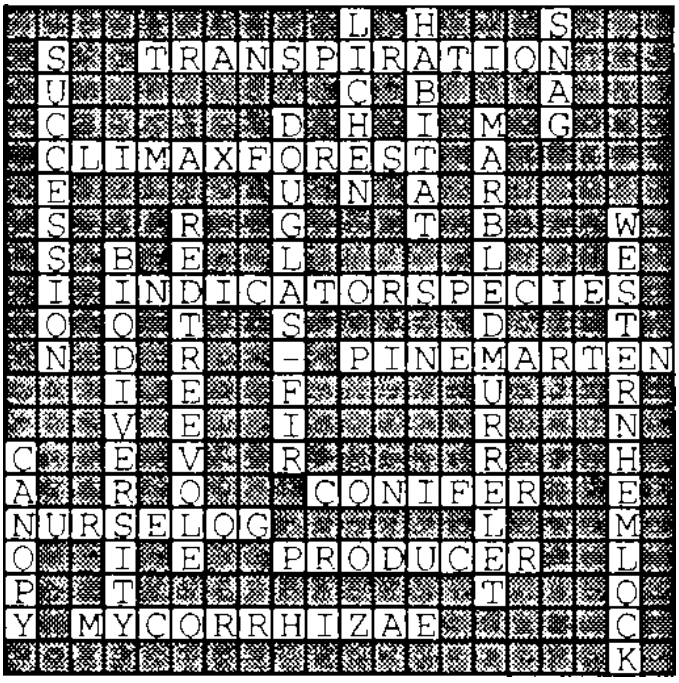
Word Search



Match-Up

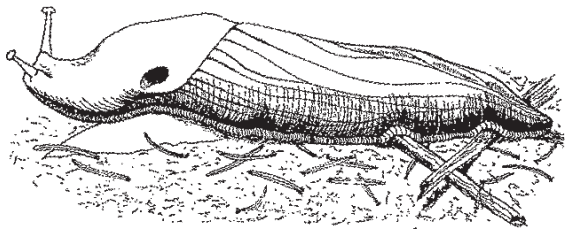
1) F
2) H
3) E
4) B
5) D
6) G
7) L
8) A
9) K
10) C
11) J
12) I

Crossword Puzzle



OLD GROWTH WORD SEARCH

A T R A N S P I R A T I O N O N A
N N O Y T I N U M M O C I T E S M
C U N V B I O M A S S X T H N P T
I B R E T R I O N L R M C A A O D
E R T S H P L A N Z F I G Y A T B
N A W Z E G G U A L L T E E N T U
T D V A G L C O N I F E R C D E I
F E H A T O O E B D L O R O F D C
O C I S U E J G S C E M H S T O H
R D N W P D R Y A Q T R A Y K W T
E E K R R A B S P H E K S S E L I
S R T A T I B A H O I M E T L L R
T A F I D X H O K E N S W E O R X
O R E S O P M O C E D A E M R R M
N X T V A N E B W S I C C F G M Y



Find These Words:

ANCIENT FOREST
BIOMASS
COMMUNITY
CONIFER
ECOSYSTEM
HABITAT
DECOMPOSER
NURSE LOG
RED CEDAR
SNAG
SPOTTED OWL
TRANSPIRATION
UNDERSTORY
WATERSHED
CANOPY
LICHEN

OLD-GROWTH MATCH-UP

Match each vocabulary word with the correct definition by putting the letter in front of the word next to its meaning.

A. BIODIVERSITY

B. CANOPY

C. COMMUNITY

D. DECOMPOSER

E. ECOSYSTEM

F. WATERSHED

G. MYCORRHIZAE

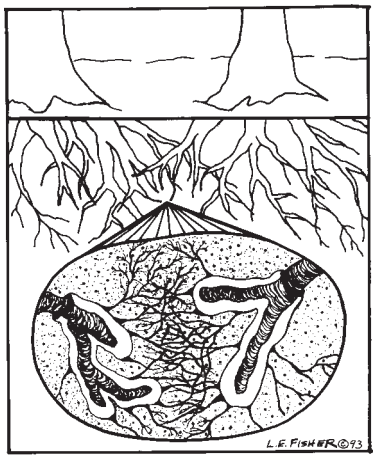
H. NURSE LOG

I. PRODUCER

J. SNAG

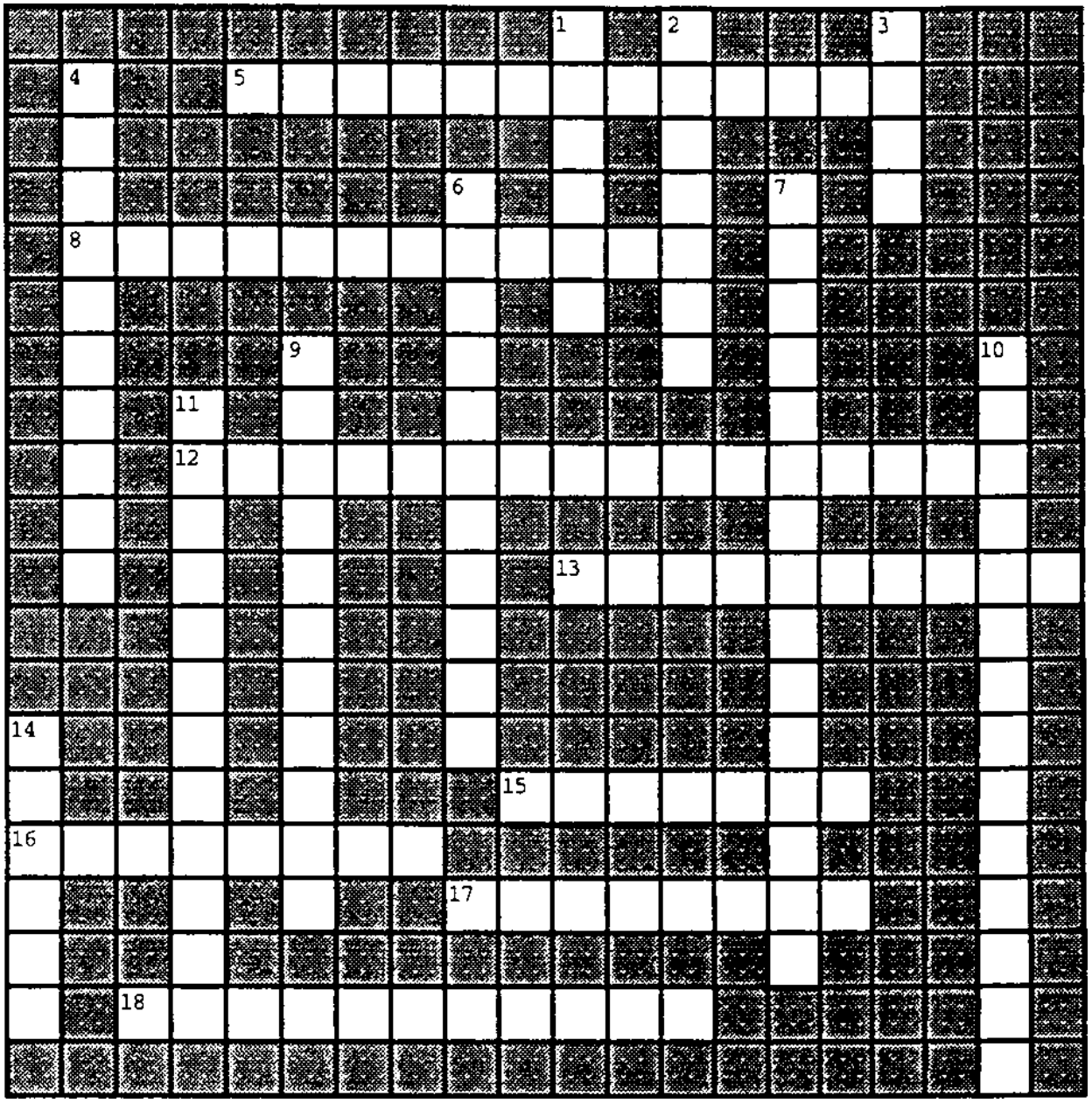
K. SUCCESSION

L. UNDERSTORY



1. ___ the entire land area drained by a stream or river
2. ___ a fallen tree which provides a place for seedlings to grow
3. ___ a community of organisms and its physical environment
4. ___ the upper level of forest vegetation
5. ___ a plant or animal that feeds on dead material, breaking it down
6. ___ the symbiotic relationship of a fungus with the roots of plants
7. ___ the forest layer of shrubs and young trees underneath the canopy
8. ___ the variety of living organisms
9. ___ the replacement of one plant community by another
10. ___ a group of plant and animals living in the same habitat
11. ___ a standing dead tree
12. ___ a plant containing chlorophyll that produces food

FOREST PUZZLE



ACROSS

5. Water evaporating from plants.
8. The final stage in forest succession.
12. A plant or animal used to identify a special environment or community.
13. A type of weasel found in old-growth forests.
15. A cone-bearing tree.
16. A fallen tree on which seedlings grow.
17. A plant with chlorophyll that makes its own food.
18. The relationship of a fungus with tree roots.

DOWN

1. A fungus and algae growing together in one plant.
2. A plant or animal's home.
3. A standing dead tree.
4. One plant community replacing another.
6. A tree which can grow over 200 feet tall and over 10 feet in diameter.
7. A sea bird that nests in the old-growth forest.
9. A small mammal that uses Douglas-fir trees for food and shelter.
10. A large tree that grows well in shade.
11. The variety of living organisms.
14. The uppermost level of a forest.

Old-Growth Web of Life

Subjects
science

Skills
classification
categorizing
hypothetical thinking
gathering information

Materials

• words and/or pictures of natural elements in old-growth forest ecosystem

• worksheets *(Animals of the Old-Growth Forest, Old-Growth Forest Facts, Plants and Animals Feeding Types, Habitat Relationship Words, Old-Growth Forest Worksheet* and *Teacher's Answer Sheet)**

** provided*

Vocabulary
ancient forest
old-growth
snag
producer
herbivore
carnivore
scavenger
parasite
decomposer
lichen
mycorrhizae
red tree vole
spotted owl

(cont. next page)

Learner Outcome

Students will gain an understanding of the complexity of interrelationships within an old-growth forest ecosystem.

Background

A remarkable web of interactions exists within the ancient forest, not only a few feet above the ground but also underneath the soil and in the canopy above our heads. Some interactions are direct and/or obvious, e.g. one animal feeding on another, while others are not, e.g. the association of fungal cells in contact with tree roots that exchange food and minerals.

Old-growth forests are homes to many kinds of plants and animals and their value as habitat is a result of a unique combination of features. An old-growth forest experiences lower wind speeds, higher relative humidity, slower temperature changes and lesser snow depths than other types of forests. The milder climate and year-round availability of food resources results in a high animal diversity. The diversity and longevity of giant conifers are also characteristic of the ancient forests in the Pacific Northwest. No place on the planet has more species of cone-bearing trees that reach such great dimensions. Time is allowed for slow growing species, such as lichens, to become established and for a variety of foods (seeds) and spaces to be created. Spaces are created as well by a number of different disturbances occurring in such an environment – fires, windstorms, diseases, floods, landslides, and volcanic eruptions. Plant and animal species and communities of plants and animals, having the right light, temperature and soil requirements are able to persist due to the conditions that result from such disturbances.

An ecosystem is a community of organisms and its physical setting. Old-growth ecosystems support more living plant material than any ecosystem measured so far except for the coastal redwoods. In addition, snags and downed logs provide microhabitats for species and are essential for biological processes involving energy, nutrients and nitrogen fixation (the conversion of atmospheric nitrogen into a usable organic form).

It has become evident that we cannot manage one species without understanding its community and ecosystem. When one component is lost, the consequences are felt throughout the system. This is why protecting an endangered species won't work without protecting their ecosystems and why biodiversity, the variety and variability of living organisms, is so vital to the future of our forests.

Vocabulary
(from previous page)
pine marten
biodiversity
nitrogen fixation
habitat
ecosystem
community
conifer

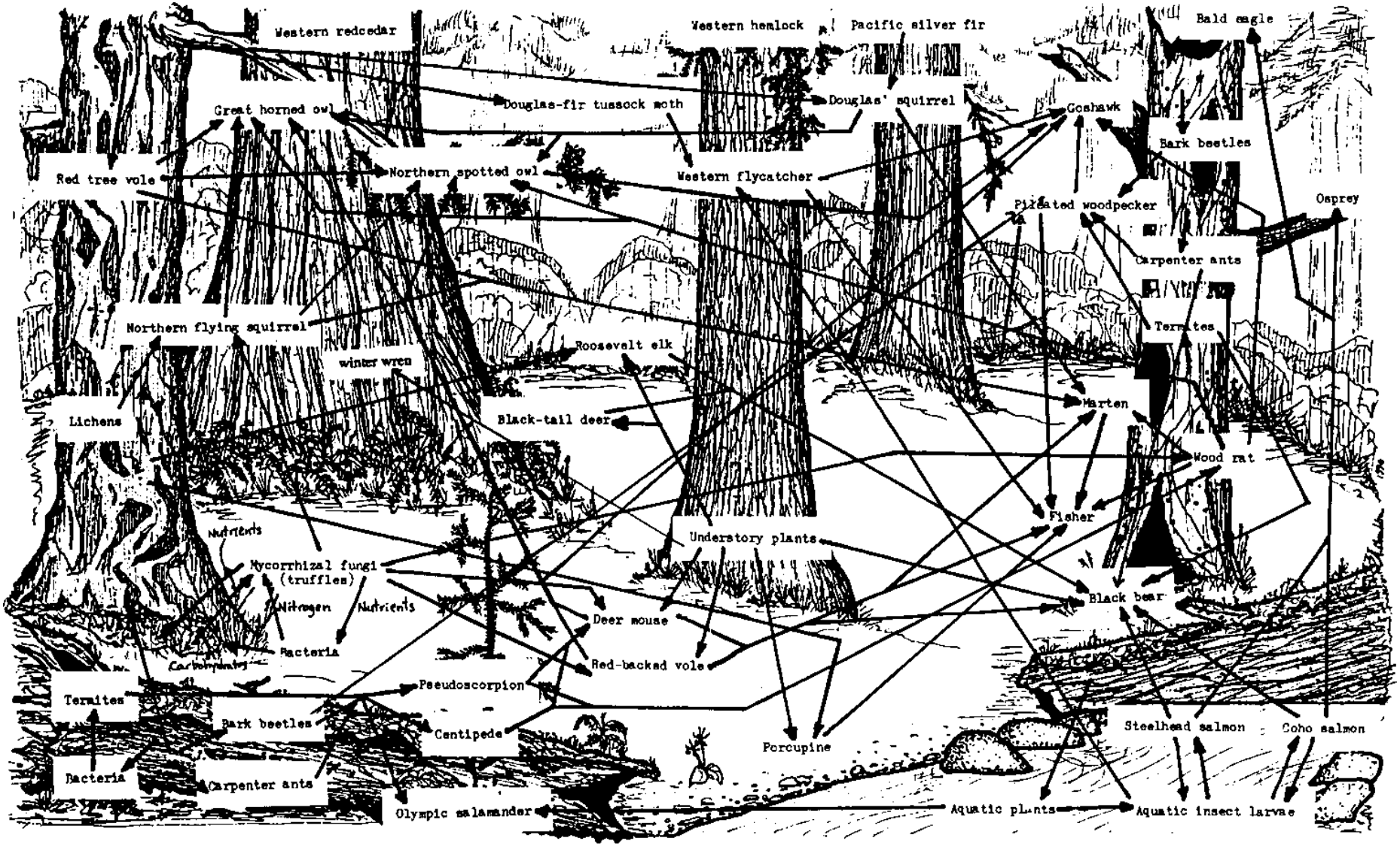
Procedure

1) As a class, brainstorm components of old-growth forests (See "Recipe For a Forest" in *Sharing Nature With Children* by Joseph Cornell).
2) Make copies of the "Old-Growth Forest Fact Sheet" for students to read.
3) Give students individual copies of "Old-Growth Forest Worksheet" (or enlarge for bulletin board project/ display.)
4) Copy, then have students cut out and place "Animals of the Old-Growth Forest" in approximate positions on the "Old-Growth Forest Worksheet." (Choose either words or pictures of animals for activity.) Referring to the handout with the feeding type codes, students may color code each living element to indicate their feeding type. (Use colored dots or stars on cut-out animals, keyed to a list in corner of the bulletin board.)

dark green	=	*producers*
light green	=	*herbivores*
red	=	*carnivores*
yellow	=	*omnivores*
blue	=	*scavengers*

5) Draw feeding-type relationship lines, as shown on the "Teacher's Answer Sheet." (You may want to color-code lines by category using a marking pen.)
6) If desired, cut out "Habitat Relationship Words" strips and repeat steps 2 and 3, linking animals with how they use the habitat.

(from "Old-Growth Web of Life" in North Cascades Institute's *Living With Mountains*)



OLD GROWTH FOREST WORKSHEET

TEACHER'S ANSWER SHEET

OLD-GROWTH FOREST FACTS

- An old-growth forest is a highly complex system of interacting plants and animals which has the following structural features:

  … large, standing old trees
  … large snags
  … large, fallen trees
  … multiple-layered canopy

- Old-growth forests in the Pacific Northwest exceed even the tropical forests in producing living matter, including plants, animals, fungi and bacteria.
- A single old-growth tree may be home to as many as 100 plant species.
- More than 1,500 species of invertebrates may live in the canopy of an old-growth forest.
- More than 200 wildlife species have been counted in old-growth forests, from owls to deer and voles to bear.
- The water content of the canopy – 264,000 gallons per acre – softens the effects of winter weather, providing stable-temperature habitat for species such as elk.
- Tree limbs and logs slow erosion and sedimentation of streams that supply drinking water and provide clean spawning beds for trout and salmon.
- Dead old-growth trees, some up to 1,000 years old, provide homes, shelter and food to an abundance of life as they fall, slowly decay, and decompose into the ground.
- The characteristics of old-growth forests take at least 175 years to develop in the Northwest, and much longer to reach their full potential.

PLANTS AND ANIMALS OF THE OLD-GROWTH FOREST

FEEDING TYPES

1 = PRODUCER
2 = HERBIVORE
3 = CARNIVORE
4 = SCAVENGER
5 = PARASITE

1	Pacific silver fir	3	Western flycatcher
1	Western red cedar	3,4	Bald eagle
1	Western hemlock	3	Osprey
1	Douglas-fir	3	Goshawk
1	Mycorrhizal fungi (truffles)	3	Great horned owl
1	Bacteria	2,3,4	Black bear
1	Lichens	2,3	Deer mouse
1	Aquatic plants	2,3	Red-backed vole
1	Understory plants	2	Red tree vole
2,3	Olympic salamander	2,3	Wood rat
2,5	Douglas-fir tussock moth	2	Douglas squirrel
2,5	Bark beetle	2	Northern flying squirrel
2,5	Carpenter ants	2,4	Pine marten
2,5	Termites	2,4	Fisher
3	Pseudoscorpion	2	Porcupine
3	Centipede	2	Roosevelt elk
2,3,4	Aquatic insect larva	2	Black-tailed deer
3	Coho salmon	3	Spotted owl
3	Steelhead	3	Pileated woodpecker

FOOD RELATIONSHIP WORDS

PRODUCERS .....grow, photosynthesize, make sugars
HERBIVORES .....graze, browse, nibble, crop
CARNIVORES .....eat, hunt, stalk, prey upon, kill
OMNIVORES .....(see herbivore and carnivore)
SCAVENGERS .....scavenge, eat dead things
PARASITES .....live off plants and/or animals
DECOMPOSERS.....breakdown, decompose, rot

Habitat Relationship Words

(cut along lines)

Live in, on, under, near (or be lived in, on, etc.)

Give or receive shelter from enemies and/or weather

Avoid

Prevent growth of, encourage growth of

Dwell, inhabit, occupy

Raise a family in, on, etc., reproduce

Provide

Nest, roost

Sleep in, on, etc.

Eat in, on, etc.

Destroy

Die

Damage

Spread

Fertilize

Carry, move, transfer

OLD GROWTH FOREST WORKSHEET

aquatic larvae

centipede

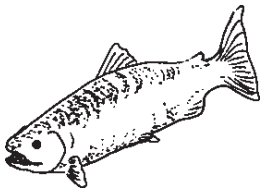
pseudoscorpion

bark beetle

carpenter ant

termite

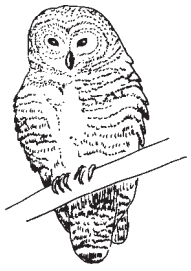
Olympic salamander



Coho salmon

Osprey

Goshawk

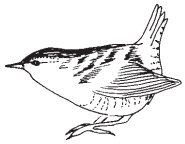


Northern spotted owl

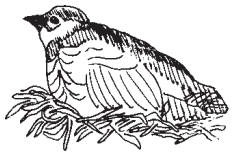
Great horned owl

Pileated woodpecker

Western flycatcher



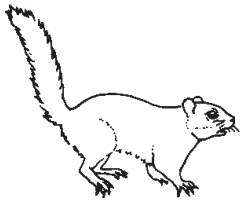
Winter wren



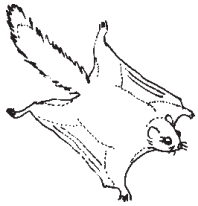
Marbled murrelet

Wood rat

Red-backed vole



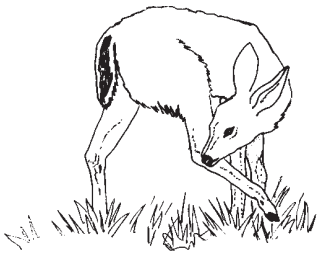
Douglas squirrel



Northern flying squirrel

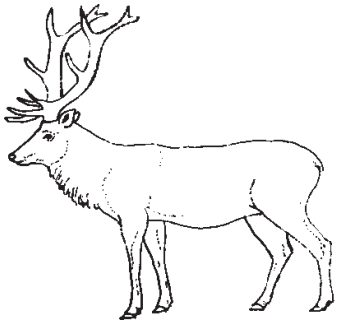
Fisher

Pine martin

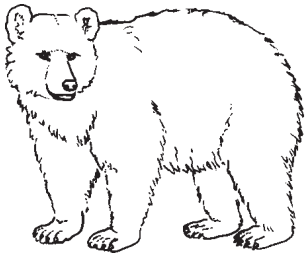


Black-tailed deer

Porcupine



Roosevelt elk



Black bear

An Imaginary Hike

Subjects
art
language arts
science
music

Skills
listening
artistic representation
creating
describing

Materials
- guided imagery script (optional)*
- music/portable player (optional)
- paper and drawing supplies

** provided*

Vocabulary
Douglas-fir
western hemlock
western red cedar
lichen
nurse log
canopy
ancient forest

Learner Outcome

Students will become aware of the characteristics of an old-growth forest and describe them with words and drawings.

Procedure

Using Visualization

Before the days of television, people were entertained by listening to the radio and imagining a variety of people, places and events. Guided visualization is an effective way for students to create vivid pictures and feelings through their mind's "eye". Research shows that visualization utilizes parts of the brain unstimulated by reading, writing, or visual media. Writing and reading skills can actually be enhanced by the use of visualization. It can also improve the ability to remember ideas, names, concepts and words, and with regular use may help students relax, which frequently leads to greater productivity.

Preparing Your Students

1) Find out if any students have ever been to an old-growth forest. What was it like? Encourage them to share descriptions of any old-growth forest they may have been to or seen pictures of.
2) Ask students to put away all possible distractions such as pencils, books, games, etc.
3) Instruct students to sit in a comfortable position, close their eyes and take three deep, long breaths to relax. Tell them they will be imagining the things you will be describing.
4) Wait until you see a general state of relaxation before proceeding.
5) Read or speak slowly, calmly and steadily. Allow plenty of time in the narration for their imagination to visualize and absorb each scene.
6) Narrating to appropriate background music helps to deepen the mood.
7) With younger students, or groups with a short attention span, shorten your presentation by omitting secondary facts and some of the mood-setting description.
8) When the narrative is over, before the students open their eyes, review all the images they saw. Have them recreate their favorite image in their minds, trying to capture the details.

9) Have students share their strongest image with the class by drawing or painting their favorite part of the "hike" and then displaying it. Remember there are no mistakes in mental images and what a child imagines is real to them. Honor and nourish different perspectives.

Suggested Recordings to Accompany "An Imaginary Hike"

Earth: Voices of a Planet, Paul Winter, Earth Music Productions, Litchfield, CT (esp. "Cathedral Forest")

Earth Songs, Various Artists, Narada Productions, Milwaukee, WI

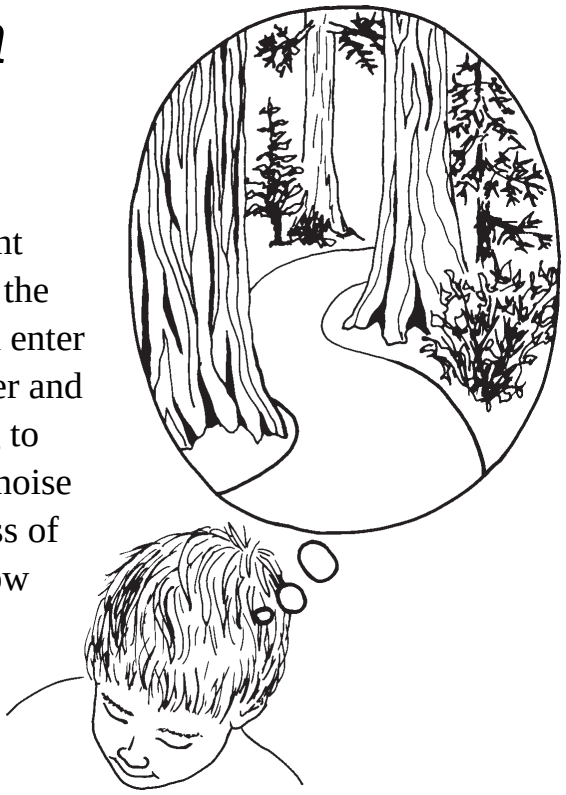
Narada Wilderness Collection, The, Varied Artists, Narada Productions, Milwaukee, WI (esp. "Fragile Majesty", "Madre de la Tierra")

Shepherd Moons, Enya, Reprise Records, Burbank, CA

Watermark, Enya, Geffen Records, Los Angeles, CA

Woodlands, Eric Tingstad, Nancy Rumbel, David Lanz, Narada Productions, Milwaukee, WI (esp. "Woodlands", "Deodora", "Sequoia", "Willow")

A Hike Through an Old-Growth Forest



It is a warm summer day. You are in Mount Rainier National Park at one of the trailheads of the Wonderland Trail. As you step onto the path and enter the woods you immediately feel the air get cooler and the green shade of the towering trees is soothing to your eyes. With a few more steps you leave the noise and speed of the road behind as the quiet stillness of the living forest surrounds you. The ground below your feet is soft from layers of fallen needles.

Off the trail the forest floor is covered by a thick, luxurious green carpet of moss. You bend down to feel its softness and see another soft part of the forest – a banana slug! This one is about six inches long and jet black. You watch it for a few minutes as it slides slowly along the ground on its own trail of slime, its two tentacles sensing the world around it.

Continuing along the trail you are amazed by the great size of the trees! You stretch out your arms to give a Douglas-fir a hug and it is so wide you can't get your arms around it. It would take several people to reach all the way around. The bark is thick with deep ridges. You can smell the dryness of the tree's skin and see a bark beetle digging its way through the layers. You wonder how old this Douglas-fir is – 200, 300, 500 years or more?!

There are other huge trees nearby – western hemlocks with lacy branches of short needles, the new growth a lighter, fresh green; western red cedar with its distinctive stringy bark and drooping, scaly leaves. You look up the trunks of these giants. Decorating their branches is what looks like green Christmas tree tinsel. Looking at it closer you see it is really a plant called goat's beard lichen that does not need soil to live and grow.

Suddenly you hear a noisy chattering coming from one of the higher branches and follow it until you see a bushy tail twitching back and forth. It's a Douglas squirrel scolding you for intruding on its territory. It is holding a Douglas-fir cone, shelling out the tasty seeds. Moving your eyes past the squirrel, up the trunks, you try

to find the very tops of the trees but they are so tall that the uppermost branches become lost. Your neck starts hurting as you strain to see. They must be over 200 feet tall – as much as a 20 story building!

You move farther down the trail, with the same Douglas squirrel as background music, and come to a large fallen log. It is almost as tall as you, even when fallen over. Picking up a piece of the decaying wood, it feels like a sponge and you squeeze some water from it. On top of the log there are several young hemlock trees growing, as well as some moss and mushrooms. These plants are getting a head start on life and taking needed nutrients and moisture from the large "nurse" log.

Not far from the nurse log you see another dead tree but this one is standing up instead of toppled over. The bark has fallen off and you see large oval holes halfway up the trunk. As you wonder who could have made these, from the other side of the tree comes a loud hammering. The sound is from a large, crow-sized woodpecker with a bright red crest. It ignores you as it digs for wood-dwelling insects. Then with sweeping wingbeats it flies off to another tree snag in search of more tidbits.

From there the trail crosses a clear tumbling stream. The water is ice cold to the touch as it rushes over and around rocks and fallen trees. Small eddies and pools have been created by the obstacles in the water. There is a trout hiding in the calm, maybe waiting for a smaller fish to come by and become its dinner. You decide to sit and watch the water for awhile. The song of the stream is pleasant to listen to. You are being very still and quiet. Out of the corner of your eye you detect some movement near the water's edge. You slowly turn your head and find a black-tailed deer getting a drink from the stream. Its ears are alert and its large dark eyes keep watch for possible danger. You barely breathe so not to disturb the doe. It is so graceful. When she finishes drinking, the doe crosses the stream and disappears into the dark forest beyond.

It is time for you to head back home so you reluctantly leave your spot on the streambank and retrace your steps. The sunlight is filtering through the tree branches to the forest floor below. You notice the many different bushes, ferns and other plants growing under the sheltering canopy of trees. A long two-pitched whistle rings out of the air. Somewhere in the treetops a varied thrush is proclaiming its place in the world.

After spending time out in nature, you feel refreshed and relaxed. You leave the trail knowing that you can return again to explore more of the secrets of this lush, diverse mosaic. For centuries, the old-growth forests have been a home for many plants and animals, providing food, water, shelter and protection. You realize now that a forest is more than trees.

How Wet Are Your Woods?

Subjects
science
math

Skills
group process
measuring
experimenting
predicting
describing
interpreting
discussion
comparing

Materials
- 4 identical jars with lids
- clipboards
- *How Wet Are Your Woods?* worksheet*
- pencil
- plastic bags
- rain gear
- measuring cups or graduated cylinders (optional)

** provided*

Vocabulary
rainshadow
canopy
fog drip
transpiration
epiphyte

Note: This activity can also be done on-site at Mount Rainier.

Learner Objective

Students will compare the amount of water falling in the forest under different conditions.

Background

The Pacific Ocean is the source of the mild temperatures and moisture-filled clouds blanketing western Washington most of the year. Mount Rainier is the first major high land mass which maritime air encounters when moving inland from the southwest. The warm air is forced to rise to get around the mountain's shoulders which causes the moisture to cool, condense and precipitate.

Most of the precipitation falls on the southwest side of the mountain; the northeast side is drier. This is called a rain-shadow effect and results from the depletion of the moisture in the clouds by their precipitation on the south side of the mountain first. The average annual precipitation at Longmire is 80"; Paradise is 125"; Seattle 30" and Yakima 7". Precipitation amounts vary with the elevation as well as the position around the volcanic cone. There is less water stress at the higher elevations because of snowmelt, runoff, and fog and cloud condensation, as well as a shorter growing season. At the low to intermediate elevations, the summers are drier and the forest's transpiration or water evaporation rate is higher.

A forest's canopy or uppermost level, is an incredible filtering system. A single 400 yr. old, 250 ft. tall Douglas-fir tree can have 60 million needles (a surface area equivalent to one acre) which are highly efficient at trapping and absorbing the nutrients in rain and fog. Droplets collect on the tips of the needles and fall to the ground.

The uneven canopies of old-growth forests create a turbulence in the air which increases the chance of collisions between moisture droplets and conifer needles. An estimated 8 inches, or 35% of the annual precipitation under an old-growth canopy, is the result of fog drip. Thus fog can be critically important to plants and animals at Mount Rainier, especially during the dry summer months.

The forest canopy acts as a climatic buffer. As precipitation increases, the daily temperature range and maximum temperature decrease. This reflects the large water holding capacity of the canopy, approximately 264,000 gallons (1.25 inches) per acre. Such a reservoir is important to the survival of

epiphytic lichens inhabiting the canopy. These plants are metabolically active when wet; dormant when dry. Some of the canopy's nutrients dissolve and form thin rivulets down the tree trunks, possibly being intercepted by other epiphytes.

Procedure

This activity works best when incorporated with another activity, as it involves collecting rainfall, a process that takes at least thirty minutes. This is also a good activity to do on-site at Mount Rainier if it is raining when you take your field trip. Collection jars can be set out at the beginning of your stop at Twin Firs or Longmire and then retrieved and examined shortly before you are ready to leave.

1) Divide the students into four groups and assign one recorder for each group to take notes on the "How Wet Are Your Woods?" handout.
2) With the students, find four different spots to place the rainfall collection jars. Each group will be responsible for one site. If possible, find the following types of conditions for the jars:
   - A clearing with a good view of the sky when you look straight up. Edges of parking lots or wide spots in trails can make good locations.
   - The base of a large tree (at least a foot in diameter). Put the jar next to the base of the tree.
   - On the forest floor among a number of trees. Try to put the jar at least four feet from the nearest tree trunk.
   - Beneath some overhanging leaves of a shrub or large fern.

   If you can't find places that fit all of the conditions described above, look for other types of areas. The important thing is to compare the amount of rainfall that hits the forest floor under a variety of conditions.
3) Using the worksheet, have each of the four groups study and describe the conditions at their collection site. After the groups have described their sites on their worksheets, tell them that they will be returning to their sites later to collect the water in their jars.
4) After thirty minutes have gone by, return to the collection sites. Have the students collect their jars and cap them, making sure not to spill any of the rainfall that has collected in them.
5) Gather the students together again and discuss the findings of each group. First have each group present the conditions at their site. (If you are back in your classroom, have a student from each group write their findings on the chalkboard.) After each of the four groups has described their site, discuss with the class where they would expect to find the least amount of rainfall, the most, and why. Record the students' predictions. Next, have each group reveal how much water is in their jar. Ask the class if the results are as everyone expected, or if there are surprises. What may have caused the surprising results?

6) Ask the following questions:

Why is there such a difference between the amount of rain that was collected in the open spot and the amount that was collected next to the tree trunk?

What happened to the "missing" water? (Much of the rain that falls in the forest is deflected by branches and leaves, finally running down the trunk to the ground. This water also helps support the wide array of lichens, mosses and other plants that grow on trees in the forest.)

If less rain falls next to a tree's trunk, how does the tree get the water it needs?

Where would animals be most likely to seek shelter?

What do the results mean for the forest?

What would this forest be like if western Washington did not receive so much rain?

(adapted from "Save This for a Rainy Day" in Olympic National Park's *The Living Forest*)

Extension

Set up a weather station outside your classroom and keep a daily record.

How Wet are Your Woods

After you find a place for your collection jar, observe the area around you. Use this sheet to record your information.

1) When you look straight up, how much of the sky is covered by tree branches and leaves? (about half, three quarters, none?) Describe what you see.

2) What kinds of plants are growing near your jar? (trees, ferns, mosses, other small plants?)

3) How close is your jar to the nearest tree or shrub?

4) How soggy is the ground around your jar? Are there muddy spots nearby? Are there puddles, or has all the water soaked into the ground?

5) Are you standing on a hillside, or is the ground level where you are?

6) After 30 minutes, measure the amount of water collected at your site. Record the amount here.

Forest Study Plot

Subjects
science
math

Skills
mapping
measuring
observing
estimating
describing
classification
spatial understanding
identification

Materials
(for each group)

- 60 foot length of string, marked at 15 foot intervals and wound around a stick
- thermometer

Note: This activity can also be done on-site at Mount Rainier.

Learner Outcome

Students will be able to measure and make a grid map of an area near their school.

Procedure

1) Find an area in your school grounds or nearby that is large enough for several 15 x 15 foot plots.
2) Divide class into groups of 5 or 6 students. Distribute a 60 foot length of string to each group and assign each group to an area to set up their 15' x 15' square plot. Mark off their plots with the premeasured string. It may help to have one student stand at each of the four corners and hold the string until it is positioned. Sticks or stones may then be used to hold the string in place.
3) Students will be mapping their plot on a simple 3 x 3 grid of nine squares. Explain to the students they will need to estimate the approximate locations of the living and non-living components in their plots. They will also be using the key shown on their grid sheet to represent these components. If something is located in their plot which is not included in the key, the students may create their own symbol for it.
4) Have student groups complete the Forest Study Plot worksheet.
5) Compare grids back in the classroom and have students share what they found in their plots. If planning to do this activity on a trip to Mount Rainier, explain to the class they will be doing a similar study plot in the park.
6) If unable to visit Mount Rainier, you may want to contact the park's Education Office, (206) 569-2211 ext. 3313, to obtain a copy of forest grids done by other classes to compare with your school site.

Forest Study Plot

1) Mark off your 15' x 15' study plot in the area that your teacher assigns you.

Study your area, looking at everything, from the trees and smaller plants, to the logs on the ground, soil, light, animals, etc.

Take the temperature of the air and soil and write it down here.

Air: _____ Soil: _____

Is your area sunny, shady, or in between? _____

2) Answer the following questions:

How many different kinds of trees are there? _____

Write down the names of any trees you can identify:

_____

Estimate the height and circumference of your largest tree. (*Hint: the length of your outstretched arms is approximately equal to your height*.)

Height: _____ Circumference: _____

Are there any plants living on the trees? Describe them:

_____

How many other kinds of plants are there? _____

Name any of these that you recognize:

_____

How many fallen logs are there? _____

Feel one and describe it: _____

What will this rotting log turn into? _____

How many snags or standing dead logs? _____

Why are they important to the forest? _____

Do you see any animals or animal signs? _____

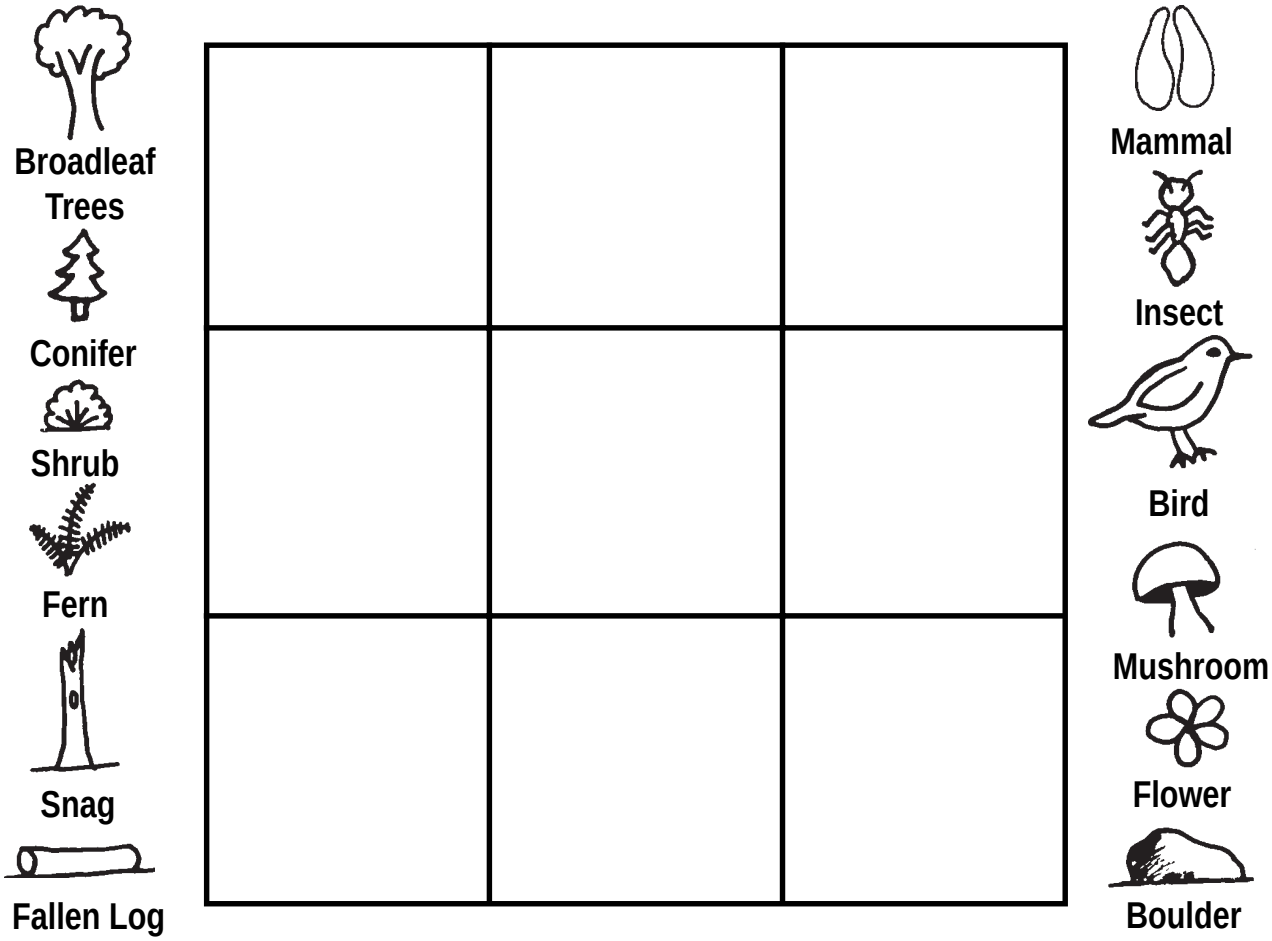
If so, name them: _____

Feel the soil for its texture and moisture. Describe how it feels.

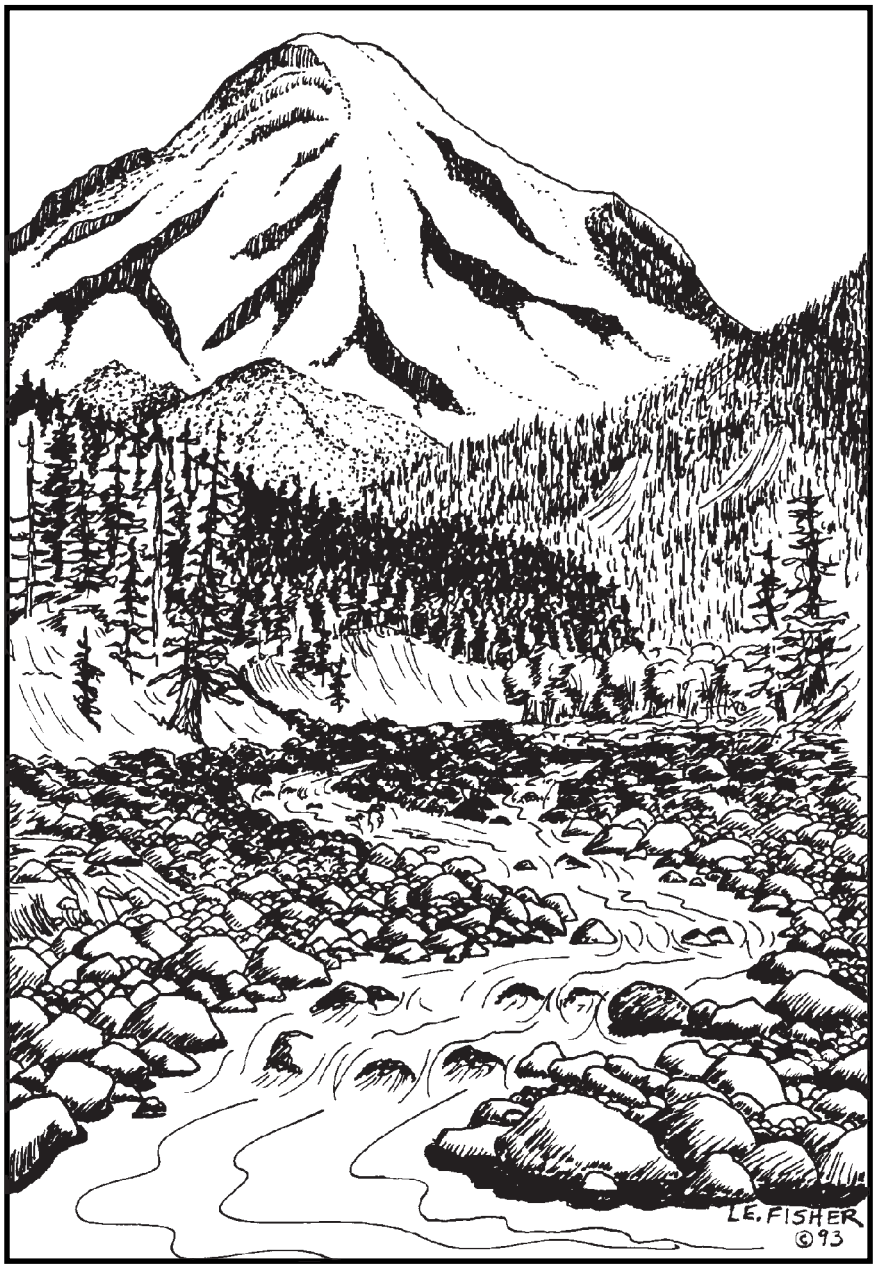
_____

3) Map your plot on the grid below.

Use the symbols in the key to show the location of the trees, plants, logs, snags, etc. in your study plot. Include tree circumferences and species, if possible.



Glacial Rivers



"Rushing recklessly onward...meeting obstacles unforeseen, turning right and left,
leaping barrier rocks, now outspread in thin plumes, scattered, divided;
now closely compressed, in abounding energy moving onward resistless..."

– John Muir

Braid a River

Subjects
science
art

Skills
observation
experimenting
artistic representation
cooperation

Materials
- construction paper
- sand or soil
- water soluble blue ink or thin paint
- pitcher or other container of water
- newspaper
- painting smocks
- paper and pencil
- straws
- watercolors

Vocabulary
watershed
braided stream

Learner Outcome

Students will be able to identify the features of a river system and explain how a stream becomes braided.

Background

No part of a stream or river travels in a straight line. Instead they follow the contours of the land. In many areas, there are characteristic drainage patterns, often resembling the branches of a tree.

Glacier-fed rivers typically wander across wide, rubble-strewn beds, dividing into separate channels and reuniting. This pattern is called braiding since it resembles the strands of a braid. (Braiding may also occur on non- glaciated lowland streams where sediment deposits are deep and the gradient is slight e.g. sandy deltas.) The intricate network of interlacing channels is caused by obstructions in the streams resulting in and from sediment deposition. When stream water picks up more gravel and rock than it can carry, the load is redeposited and a new channel is scoured around the obstacle. Braiding is a sign that active deposition is in progress.

Procedure

1) Pass out a piece of construction paper and a straw to each student. You may want to have students paint the paper with watercolors first to represent land, then allow paint to dry.
2) Put a small puddle (several drops) of blue ink or thinned paint at the edge of each piece of paper.
3) Have students blow through the straw directly onto the ink or paint. Be sure that the students are blowing into the side of the drop from the same level as the paper, not down on top of the drop. The ink/paint drop should spread out in a branching pattern similar to that of a river and its tributaries. Warning: this can be messy!
4) Tell the students that they have made an imaginary river system. The force of their breath served as the wind or a force of nature to make the paint/ink (river source) drain or run onto other areas of the paper (land). They can name their river the Nisqually and name the major tributaries after other streams and rivers found in the Nisqually River basin. Remind students the Nisqually Glacier is the headwaters of the Nisqually River.

5) Now that the students have an idea of what a river system is, have them build a model of one in the classroom or on the schoolgrounds. Divide the students up into groups of 8-10 and position each group in an appropriate spot to build their river system.

6) Outdoors, have the students mound sand or soil into a small hill, then pour water slowly onto the hill. A small tub to contain the sand/soil works well as an indoor alternative.

7) Students should draw what they see, then label the source of the river, the tributaries, and the mouth.

8) Have the students experiment with different slopes on the hill and different water flows to see the effect on the formation of their rivers.

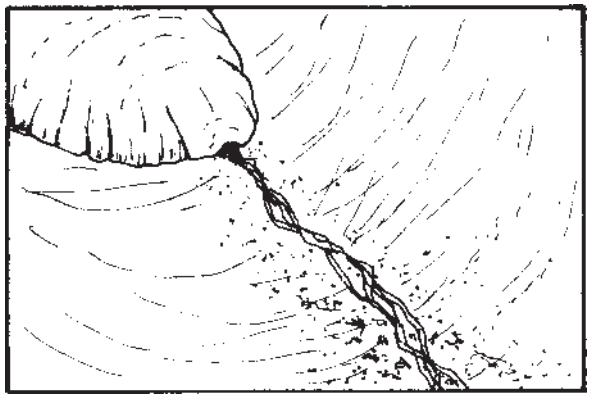
9) Introduce the concept of braided streams by first demonstrating braiding with a student's hair or using three pieces of different colored yarn. Then have the students make a braided stream model on their sand/soil hill by placing small pebbles in the stream's path, causing the water to be deflected and flow around the obstruction.

10) Explain to the students that the Nisqually River is braided in Mount Rainier National Park because of the steep slope it is flowing down and because of the heavy sediment load it is carrying from the Nisqually Glacier.

(adapted from "Make an Imaginary River System" in EPA's *Always a River*)

Extensions

Try some of the hands-on river geology activities in *River Cutters, A Teacher's Guide* (see Bibliography).



Run River Run

Subjects
science
math

Skills
cooperation
measuring
recording
using formulas

Materials
(for each group of five)
- 50 foot string
- 1 ball
- stopwatch
- pencil and paper

Vocabulary
velocity

Learner Outcome

Students will understand how to make stream flow measurements.

Background

A stream's velocity directly affects the sediment load the stream can carry as well as its ability to erode its channel. Large amounts of suspended particles in the water can tax the current's energy and actually reduce the rate of flow. Sediments accumulate wherever the water is slower e.g. in depressions, where the stream widens, or on the inside of bends.

Velocity itself is affected by various characteristics of a stream's channel. The same amount of water will flow faster in a narrow, deep channel than in a wide, shallow one because of differential friction. Streams also run faster if the channel is straight and smooth as opposed to crooked and rough. As a stream flows over a rocky bed, different parts move at different speeds. Steep gradients will result in higher speeds, other factors being equal.

A river's speed will also vary with its depth. Flow is fastest just below the water surface and slowest near the bed where friction acts as a brake.

Procedure

1) Divide the students into groups of five.
2) Have each group stretch a 50 foot string between two students.
3) Have another student then roll a ball from one end of the string to the other, calling out "start" and "stop."
4) Have the fourth student stand with a stopwatch and measure how long it takes the ball to go from the student at one end of the string to the student at the other end of the string.
5) The fifth student will be the recorder and will write down the number of seconds the ball took.
6) The next step is to determine the ball's velocity or speed per second by dividing the distance traveled by the time it took in seconds. V = D/T (sec)
7) Compare the findings of each group. Explain to the students that at Mount Rainier they will be measuring the velocity of the Nisqually River current instead of the velocity of a ball.

Extensions

1) Have students create a simulation of a river channel, with curves, obstacles, etc., then measure the differences in velocity.
2) After completing this activity on land, use the method to measure the velocity of a real stream near your school. Instructions can be found under “Glacial River Study” in the On-Site section. Compare results with the Nisqually River after your trip to Mount Rainier.

Mountain on the Way to the Sea

Subjects
science

Skills
compare/contrast
observation
measuring
recording
interpreting

Materials

- water samples from different locations on the Nisqually River
- metric rulers
- hand lenses

Vocabulary
glacial flour

Learner Outcome

Students will observe and make comparisons of the river sediment levels.

Background

Drift material carried away from a glacier by meltwater streams is characteristically well sorted and spread out to become outwash. Moving water acts like a natural sieve carrying smaller grains farther and faster than larger ones. Near the glacier you will find more boulders and gravel. With increasing distance from the glacier, the material decreases in size until eventually nothing remains except silt and sand. In contrast, the roundness of the outwash material increases further downstream.

Rivers erode and deposit sediment in response to a number of factors, such as the kind of terrain. Velocity is the single variable most directly affecting the load a stream can move and its ability to erode its channel. Within the load, some particles are dissolved in the water, some are suspended in it, and some are rolled and tumbled along the river bed. The faster the current flows, the greater and the coarser the sediment it can keep in suspension and drag along its bed. A stream doubling its speed can increase the particle size it carries by 64 times! During high water and flood stages, the proportion of sediment in the water and the total quantity of water rise sharply. Deposits built up by flooding typically flank the river channel. Because of the continuous changes in channel locations, the sediment deposits of a braided stream are constantly being reworked.

The milky appearance of glacier meltwater streams is a result of the glacier's grinding action of rock on rock, producing a fine material known as rock flour or glacial flour.

Procedure

1) In two different seasons collect samples of Nisqually River water in glass jars at locations within Mount Rainier National Park (i.e. Glacier Bridge, Carter Falls Trailhead, Sunshine Point). The park has granted special permission to teachers to collect water for educational purposes. Take samples outside the park as well, downstream to Puget Sound. Label the samples with the date and location, take back to the classroom, and display.

2) Leave the samples undisturbed for one or more weeks until all the microscopic particles settle out. (The suspended glacial flour will settle on the bottom of the jar.)

3) When the water in the jars is very clear, have the students compare the differences in suspended sediment in the river by measuring the thickness of sediment which has settled on the bottom and recording their observations.

4) Observe the sediment with a hand lens. See if there is a difference in size of the particles.

5) Ask the students the following questions: Why might there be a difference in the amount and size of the particles in different locations on the river and at different times of the year? Where did the silt come from? Explain how this sediment forms a braided stream pattern.

Extensions

1) Test water samples (pH, dissolved oxygen, temp., etc.) from locations along the Nisqually River nearest the school to compare later with samples from sites at Mount Rainier.

2) Try making your own glacial flour by rubbing different kinds of rocks together and using different amounts of pressure. How long does it take you to make "flour"? How long does it take a glacier?

3) After discussing sediment and the carrying loads of rivers, have each student select one item from the classroom, from a pencil to a chair. These articles will represent the various sizes and weights of sediment/debris carried by a glacial river (adapted from "Watershed: The Sum of the Parts", *Project WET Idaho*).

   - Make a braided river pattern on the classroom floor or playground with chalk or rope.
   - Next, have students with their article stand at the headwaters of the river (the glacier) and one at a time say out loud to their classmates what their object is, then move down to the part of the river where they think their "sediment" would be deposited and stand there (largest articles can be placed on the ground). Continue until everyone has a place along the river.
   - Discuss with the students the following questions: Which objects would be deposited first? second? last? What happens where the channels change direction?
   - Then have students rearrange themselves if necessary to demonstrate the natural sequence of stream deposition.

Shake, Rattle, and Roll

Subjects
science

Skills
hypothetical thinking
experimenting
observing
discussion

Materials
- coffee cans with lids
- watch
- small, sharp edged rocks
- sand
- round river rocks
- water

Vocabulary
erosion

Learner Outcome

Students will understand the effects of moving water and sediment on rocks.

Background

Erosion results from natural environmental forces such as wind, water and ice. Physical weathering or disintegration, is caused by mechanical action. Evidence of such a weathering process on solid rock is visible in stream channels. Rocks found in these locations are worn smooth through years of water and ice flowing over them and grinding the rocks against one another. As water flows down its course, fine particles of sand and rock are picked up and carried along. No matter how small a particle might be, it is capable of scratching, scraping and grinding off bits and pieces of rock. The faster water moves (the speed of a glacial river depends upon its slope and the amount of meltwater coming off the glacier), the more particles it can carry and the greater its erosional power. The heaviest stream loads are rolled and skipped along the bottom of the river bed and this is where most erosion takes place.

Procedure

Note: This experiment works better using softer rocks, such as shale, sandstone, or limestone.

1) Students will observe round versus jagged-edged rocks and hypothesize why rocks have those characteristics.
2) Put a handful of jagged edged rocks in each of the three cans; label cans 1, 2 and 3. In can 1, place water (enough to generously cover rocks). In can 2, place water and a handful of sand with the rocks. In can 3, place rocks only. Secure all lids.
3) Holding onto lids, shake cans vigorously for five to ten minutes (students can take turns shaking the cans).
4) After 5 to 10 minutes stop, observe, and discuss results. Ask the following:

   What happened in can 1?
   What happened in can 2?
   What happened in can 3?
   How does this apply to nature?
   How does water erode rocks?

(adapted from "How Does Water Erode Rocks?" in North Cascades Institute's *Living With Mountains*)

Extensions

1) Explore the following questions with follow-up experiments:

   Would different kinds of rock react differently?

   Would water temperature make a difference?

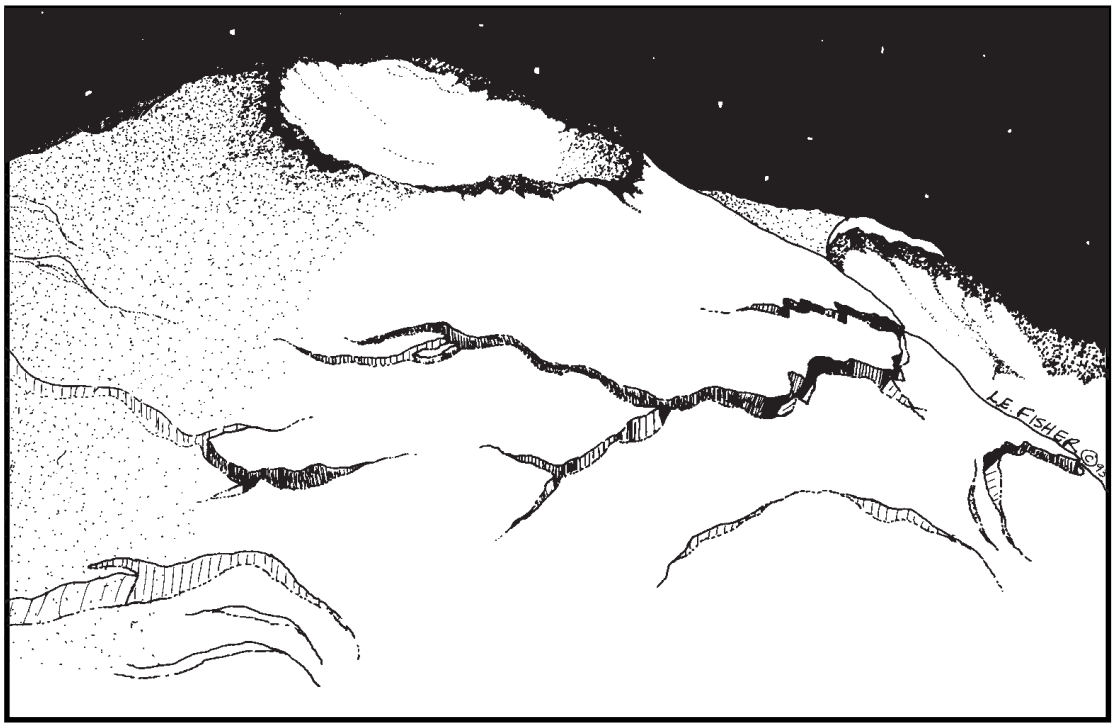
   What bodies of water would erode rocks the most? Least? Why?

   What would chunks of ice in the water do?

2) You may liken the erosional quality of water on river rocks to the effect of sucking on hardtack candy. As you continue to suck on a piece of candy it will become smoother and rounder (and smaller) due to saliva and the rolling action inside your mouth. Pass out a piece of candy to each student and give it a try (no chewing allowed!).

3) Another idea... Ask if any student in the class has a tumbler that he/she could bring in to polish rocks.

Glaciers



"Glaciers move in tides. So do mountains. So do all things."

– John Muir

Film Fest

Subjects
science
communications
social studies

Skills
discussion
listening

Materials
- movies/videos
- projector/VCR
- question sheets*

** some provided*

Vocabulary
dormant

Learner Outcome

Students will learn of the natural forces that shaped and are shaping Mount Rainier. Students will increase their understanding of the human history of the park and how the mountain is part of the Nisqually River watershed.

Procedure

Show films or videos related to the concepts of this guide. Follow up with a class discussion or use the question sheets included with this activity.

Film Suggestions

(see Bibliography for descriptions)

"Fire and Ice" (ESD #113 index #4656)
"Summit to Sea" (KIRO documentary)
"Mount Rainier" (Reader's Digest Great National Parks)

Answers to "Fire and Ice" Questions

1) A broad lowland of swamps, deltas and inlets
2) Volcanic activity
3) It was lost in a major eruption, 2,000 years ago
4) When snowfall exceeds meltoff
5) How milky in appearance the meltwater is
6) How steep the terrain is underneath the ice
7) A major mudflow caused by the collapse of the snout of the Kautz Glacier
8) It is "sleeping" and will "wake up" (i.e. erupt) someday; it may collapse into itself or it may erupt

Answers to "Summit to Sea" Questions

1) Great snow covered peak
2) Food gathering, hunting, ceremonies and celebrations
3) They feared and respected the home of their spirits
4) Gather medicinal herbs; adventure; climb the mountain; develop tourist facilities
5) Narrow, dangerous roads; more like a resort, including golf course and downhill skiing
6) 2 million; to climb, beauty and recreation
7) Answers will vary: bald eagle, salmon, beaver, great blue heron

8) Answers will vary: damming, industry, pollution

9) Answers will vary: Nisqually River Basin Land Trust, U.S. Fish and Wildlife Service (the Nisqually River Wildlife Refuge), the National Park Service

10) Answers will vary.

1) Describe what the area of western Washington we call the Cascade mountain range looked like 60 million years ago:

_____

2) What were the forces that formed Mount Rainier? _____

_____

3) What happened to Mount Rainier's original cone?_____

_____

4) How are glaciers formed? _____

_____

5) What is an indicator of how fast a glacier is moving? _____

_____

6) What determines the speed of a glacier? _____

_____

7) What event took place in 1947 that changed Kautz Creek? _____

_____

8) Scientists consider Mount Rainier a dormant volcano. What does this mean?

_____

9) What may happen to Mount Rainier's summit in the future?

_____

_____

1) What does the word “Tahoma” mean? _____

2) What were some of the reasons that the native people of the area came to Mount Rainier?

_____

3) Why wouldn’t these same Indians live at Mount Rainier or climb the mountain?

_____

4) What brought the first Europeans to Mount Rainier?

_____

5) How were the early days of Mount Rainier National Park different from today’s park?

_____

6) How many people now visit Mount Rainier each year? _____
Why do they come to the park? _____

_____

7) Name an animal of the Nisqually River basin that will be in danger if the river is not protected?

_____

8) How can the river be destroyed? _____

9) Name two groups that have been working hard to preserve the Nisqually River and its story?

_____

10) How can YOU help the river? _____

_____

Making a Glacier

Subjects
science

Skills
predicting
experimenting
following directions
observing
discussion

Materials

Session One
- marshmallows (large)
- 1 lb. small rocks
- masking tape
- cardboard circle (to fit inside jar)
- wide mouthed jar

Session Two
- marble fudge ice cream
- plastic glove or sandwich bag
- chocolate chip cookies
- baking sheet or pan
- marshmallow syrup
- table knife
- bowls and spoons

Vocabulary
glacier
density
firn
neve

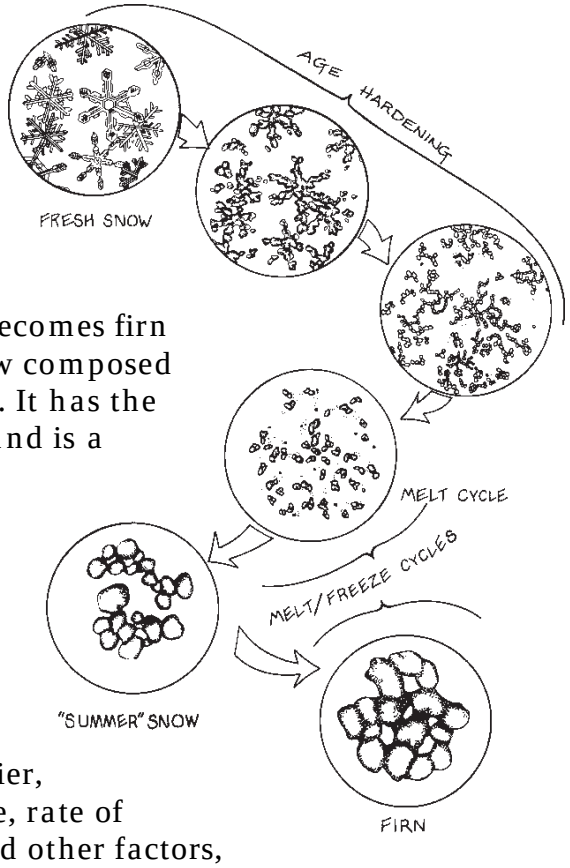
Learner Outcome

Students will understand the transformational process of snow to ice, the features of a glacier (ice, rock, crevasses), and its movement.

Background

A glacier is a moving "river" of ice formed by high amounts of snow accumulating over several years, compressing into ice, and then moving down hill under its own weight. Glaciers are not composed of pure ice, but contain rock debris of all sizes and shapes.

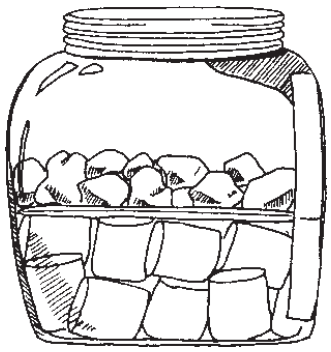
How does snow change into ice? Snow falls in crystalline form, then rounds off and loses air spaces between crystals. Air spaces make it white. Compression and selective absorption of light rays make it look blue.



The weight of accumulated snow compresses the crystals together and makes it more dense. (Density is the ratio of the mass of an object to its volume.) After a few months, by summer's end, the snow becomes firn or neve, a compacted snow composed of rounded granules of ice. It has the appearance of wet sugar and is a very hard material. Firn is denser than snow, but less dense than ice. (The density of fallen snow ranges from .1 to .3; firn .55; glacial ice .89.) The time required for the conversion of firn into ice varies from glacier to glacier, depending on temperature, rate of accumulation of snow, and other factors, but on average after about 7 years it "seasons" into glacial ice. When it begins to move it becomes a glacier!

Procedure

Session One



1) Tell the students you will be "building a glacier." Then ask what a glacier is, and guide the students to the correct definition: a moving "river" of ice formed by high amounts of snow accumulating over many years, compressing into ice, and then moving down hill under its own weight. Explain that glaciers are not pure ice, but contain rock debris of all sizes and shapes.
2) Now explain to the students that the first step in building a glacier is to transform snow into ice. Ask the students if they can guess how snow turns into ice. Tell them they will be doing a demonstration to explain how it changes.
3) Take a jar and fill it with marshmallows to represent snow. Cut a circle from a piece of cardboard that will fit snugly inside the jar without touching the sides of the jar and place the cardboard circle on top of the marshmallows. Place about one pound of rocks on the cardboard circle. Stick a piece of masking tape on the outside of the jar from top to bottom and make a pencil mark on the tape at the level of the cardboard. Put the lid on the jar and put the jar in a safe place.
4) Ask the students to predict what they think will happen to the marshmallows if they are left in the jar for a few days. Have the students observe what happens to the marshmallows in the jar, each day marking on the tape the level of the cardboard.
5) After five days explain to the students that when layers of snow build up in a glacier, their weight packs the snow closer together and makes the bottom layer melt. Ask the students how the marshmallows in this experiments are like the snow in a glacier. (T*he weight of the rocks pushed the air out of the marshmallows, just as the weight of the layers of snow compresses the air out of the snow and turns it into ice.)*

(from "How Glaciers Form" in Kelso School District's *N.I.C.H.E.S.*)

Extension

If in a snowy area, have students measure the height of snow on a stationary object over the course of winter to see the rate of compaction. If you have access to a snow density kit, use it to make observations at school or on a field trip to Mount Rainier.

Session Two

1) Now that the students understand how snow becomes ice, you are ready for phase two of this activity. Tell the students you are now going to demonstrate how a glacier moves and carries rock and soil debris with it as it travels.

2) Crumble the cookies onto the baking sheet or pan. The crumbled cookies represent glacial till, materials such as rocks and dirt that are picked up and moved by the force of a glacier and deposited as moraines.

3) Remove ice cream from container and place it on top of the cookies. Explain that the ice cream represents the glacier. Although a glacier begins as clean snow, as it travels, it picks up dirt and rocks so that it becomes streaked with dirt. The swirls of chocolate in the ice cream represent the "dirt" in the glacier.

4) Place a plastic lunch bag or glove over your hand, and compact the ice cream. Have children notice the cookies sticking to the ice cream. As more and more ice and snow fall on the glacier, the weight causes it to ooze, pushing the glacial till (cookies) in all directions, creating terminal and lateral moraines, and carrying some along with it. Using the table knife, cut crevasses into the glacier to show how the surface of the ice cracks as the glacier flows over uneven bedrock.

5) To see the plastic movement of a glacier, warm up the marshmallow syrup or add a little hot water to make the syrup slightly runny. Then pour the syrup over the ice cream.

6) Have the students observe the movement of the "glacier" and discuss how this is similar to the real movement of a glacier.

7) You may now divide up the ice cream "glacier" into bowls for all of the students.

(from "Making a Glacier" in EPA's *Always a River*)

Glacier Vocabulary

Subjects
language arts
science
art

Skills
sorting
reading
classification
questioning
illustration

Materials
• vocabulary list *(see list)*
• activity sheets *(Word Search, Match-Up, Cross-word Puzzle)**
• answer sheet*
• picture dictionary: large sheets of paper, drawing material
• guessing game: card or paper for each word; tape, pins or clothespins

** provided*

Learner Objective

Students will become familiar with new vocabulary words and be able to spell and define twelve of these words.

Glacier Vocabulary List

(see Glossary for definitions)

ablation
ablation area
accumulation
accumulation area
albedo
avalanche
cirque
crevasse
equilibrium line
firn
glacial advance
glacial flour
glacial polish
glacial retreat
glacial striations
glacier
icefall
jokulhlaup (yo-kul-hloip)
lateral moraine
moraine
Nisqually Glacier
Pleistocene
plucking
terminal moraine
terminus
till
trimline

Picture Dictionary

Assign each student one of the glacier vocabulary words. Have the students write their word with its meaning on a sheet of paper, then draw an illustration for their word on the same piece of paper. After students share their word with the class put all the papers together and make a "picture dictionary".

"What Am I?" Guessing Game

Write the vocabulary words on cards or pieces of paper (one word per card). Fasten a word card on the back of each student so they can't see it. Have them try to guess what their word is by asking their classmates yes or no questions about it (e.g. Am I cold? Do I move? Am I part of a glacier?). This can be done as a group, having one student asking the class questions, or as individuals, with all the students mingling and asking each other questions.

Word Search

(see handout)

Match-Up

(see handout)

Crossword Puzzle

(see handout)

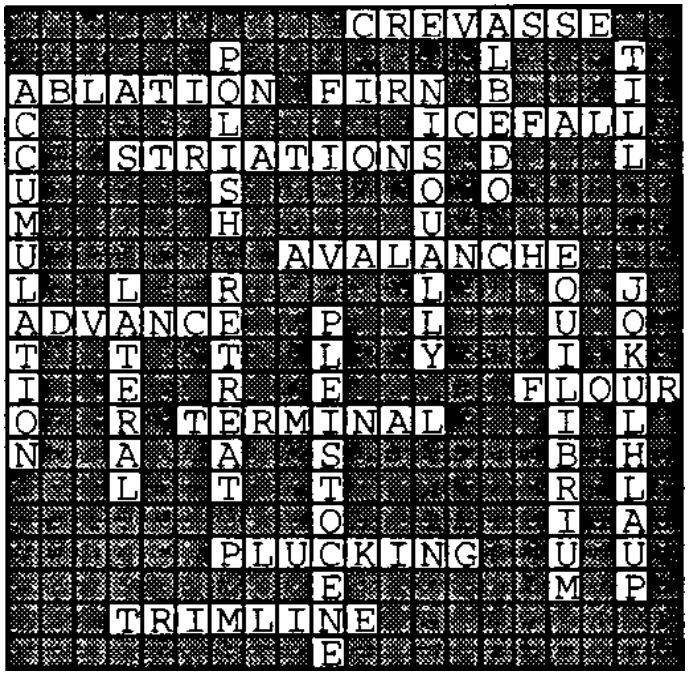
Glacier Vocabulary Answer Page

Word Search

Match-Up

1) K
2) G
3) C
4) H
5) B
6) I
7) L
8) F
9) A
10) D
11) E
12) J

Crossword Puzzle



GLACIER Word Search

T E R M I N A L M O R A I N E E
C Q S E D H E N T L Z T O Y N C
A U H N O I T A L B A L N I I Y
G I E N S I G N H I R O A R L T
P L E I S T O C E N E R Q S M E
L I A I O A U C I T O U E Y I R
U B E C W G S E R M E T R E R M
C R S E I O T A O E D U E Q T I
K I O F S E O N D L V D Z R U N
I U W A C O R D E E Y A X D M U
N M A L Y I O D B W K X S R T S
G L S L F T S A L E A R F S E D
O I L A I D E H A L L M S A E L
L N G L A C I A L R E T R E A T
W E R E H C N A L A V A S I T W

Find these words:

PLEISTOCENE
CREVASSE
TRIMLINE
GLACIAL RETREAT
GLACIER
ABLATION
ICEFALL
ALBEDO
MORAINE
FIRN
PLUCKING
EQUILIBRIUM LINE
CIRQUE
AVALANCHE
TERMINAL MORAINE
TERMINUS

Glacier Match-up

Match each vocabulary word with the correct definition by putting the letter in front of the word next to its meaning.

A. ABLATION

B. ACCUMULATION

C. ALBEDO

D. CIRQUE

E. FIRN

F. GLACIAL FLOUR

G. GLACIER

H. JOKULHLAUP

I. MORAINE

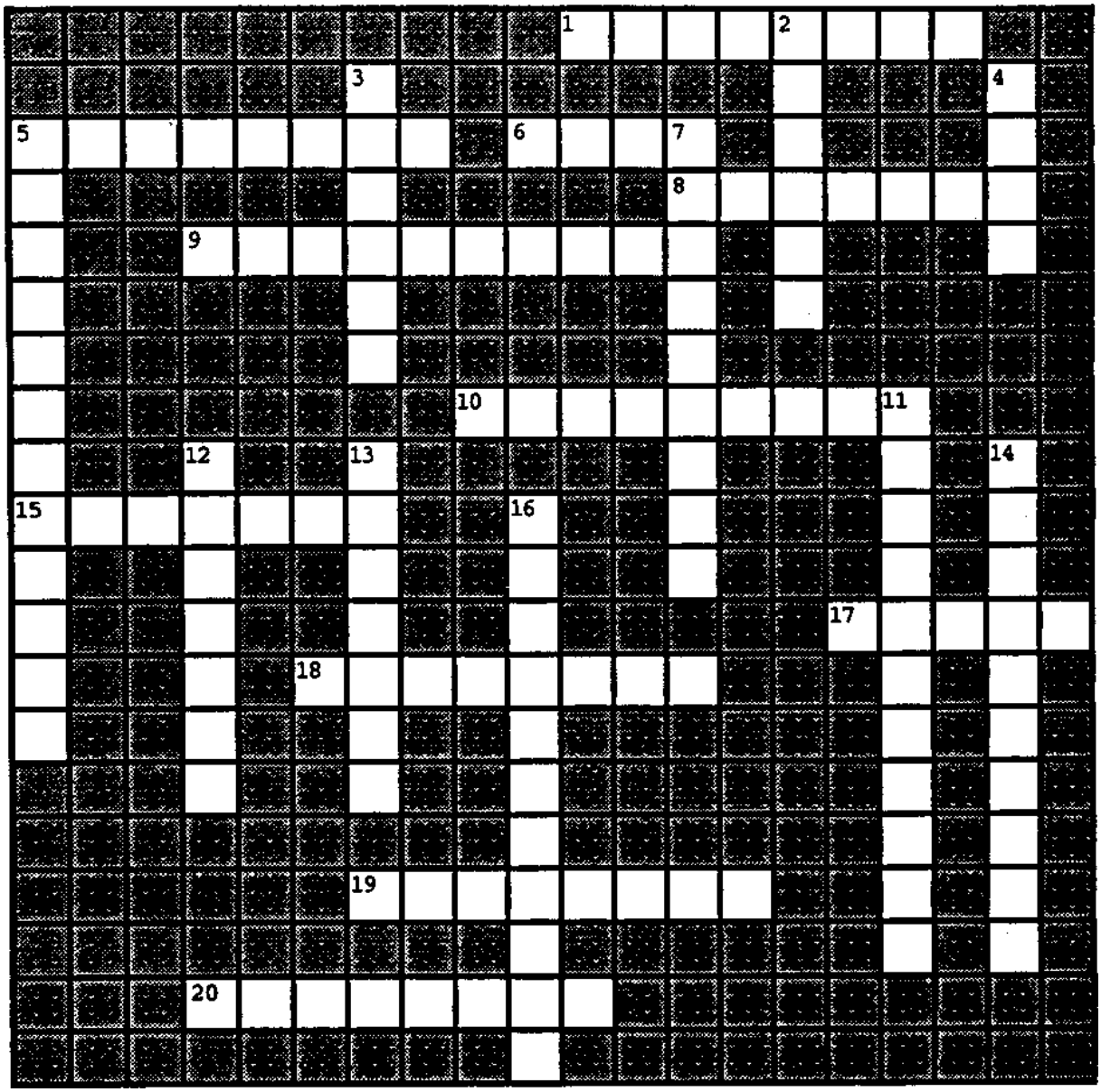
J. TERMINUS

K. TILL

L. CREVASSE

1. ___ unsorted rock debris deposited directly by the glacier
2. ___ a moving river of ice
3. ___ the reflectivity of solar radiation of a surface
4. ___ an sudden outburst flood from a glacier
5. ___ the process by which a glacier is replenished by snow and ice
6. ___ accumulation of rock material on or around a glacier
7. ___ a deep crack in a glacier due to glacial movement
8. ___ fine grained sediment in glacial rivers from erosion of bedrock
9. ___ the process by which a glacier loses snow and ice
10. ___ a large bowl shaped depression formed by glacial erosion
11. ___ a hard, compacted snow, also called neve
12. ___ the snout of a glacier

GLACIER PUZZLE



ACROSS

1. A deep crack in a glacier.
5. The loss of snow and ice from a glacier.
6. Hard, compacted snow.
8. The steepest part of a glacier.
9. Scratches in the bedrock.
10. A large mass of snow or ice sliding off a mountain slope.
15. The forward movement of a glacier's terminus.
17. Fine grained sediment in glacial rivers.
18. The moraine left behind at a glacier's snout is a _____ moraine.
19. The process by which glacial ice dislodges and picks up rock fragments.
20. A line of vegetation delineating past glaciation.

DOWN

2. The reflectivity of solar radiation of a surface.
3. The smoothing of rock by glacial flour.
4. Unsorted rock debris deposited by a glacier.
5. The replenishment of a glacier by snow and rain.
7. The name of the seventh largest glacier on Mount Rainier.
11. The boundary between the accumulation and ablation areas is the _____ line.
12. Accumulation of rocks and soil on a glacier's sides is the _____ moraine.
13. The upvalley movement of a glacier's terminus.
14. A glacial outburst flood.
16. The Great Ice Age.

Glaciers of Mount Rainier

Subjects
science
geography

Skills
questioning
research
map reading

Materials

- *Glaciers of Mount Rainier* map/ question sheets*
- pencil

** provided*

Learner Outcome

Students will learn about Mount Rainier's glacier system and develop their own questions about glaciers.

Background

Mount Rainier has one of North America's largest single peak glacier systems. Today snowfields and glaciers cover 35 square miles of the mountain. There are 25 named glaciers and about 50 small, unnamed glaciers and ice patches on the slopes of Mount Rainier. The largest glacier in the continental United States is the Emmons, which is five miles long and one mile wide. The Nisqually Glacier is the seventh largest glacier on the mountain.

Why are there so many glaciers here? Low temperatures are not enough to develop glaciers. High amounts of snowfall are also needed. A glacier forms wherever snowfall repeatedly exceeds melting over a period of years.

Mount Rainier's great height and proximity to the Pacific Ocean allow the mountain to "make its own weather." As moist air moves in from the Pacific, it bumps into Mount Rainier and is forced to rise. As this moisture-laden air rises it cools, about 1.5 degrees F for every 1000 feet. Since cool air is unable to hold as much moisture as warmer air it is forced to release this moisture as precipitation. Above the 5,000 feet elevation the majority of this precipitation falls in the form of snow, and between 5,000 and 11,000 feet is where most of the glaciers are born on the mountain. Higher than 11,000 feet, the clouds have already been "wrung out" in their rise up the slopes. Without as much moisture, there is less snowfall.

Paradise receives an average of over 50 feet of snow a year and in the winter of 1971-72 received a record snow fall of 93 feet! Mount Rainier is so heavily glaciated because of these high amounts of snowfall and cool year-round temperatures.

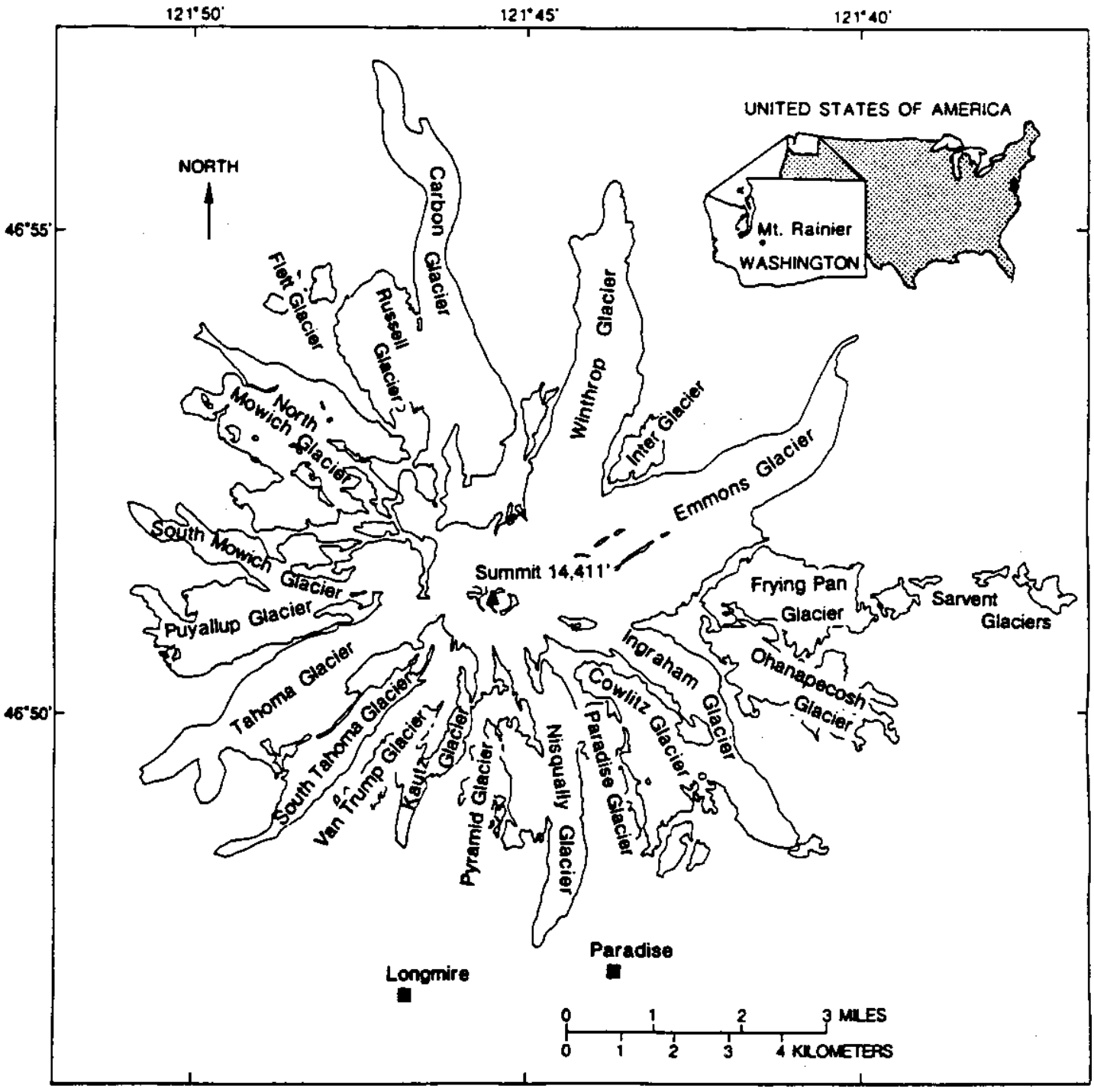
Procedure

1) Distribute the map of Mount Rainier's glaciers and accompanying worksheet to the students and have them answer the questions on the worksheet. When they finish discuss the answers with the class.

Answers to Glaciers of Mount Rainier Questions

1) 21
2) Emmons
3) Accept any four of the following: Flett, Inter, Sarvent, Paradise, Pyramid, Van Trump
4) Winthrop, Emmons, Ingraham, Nisqually, Tahoma
5) Accept any glaciers other than the five in question 4
6) Accept any of the following: South Tahoma, Van Trump, Kautz, Pyramid, Nisqually, Paradise, Cowlitz
7) North; more shade and less heating from sun on the north side of the mountain; also, the mountain catches the snow laden winds coming from the north, resulting in higher accumulations of snow.
8) Carbon
9) Answers will vary
10) Answers will vary

Mount Rainier Glaciers



Note: Mount Rainier has 25 named glaciers, not all are listed on this map.

C.L.Driedger, 1993
"Glaciers on Mount Rainier"
U.S.Geological Survey
Open-file Report 92-474

Glaciers of Mt. Rainier

Using the map of Mount Rainier's glaciers, answer the following questions:

1) How many glaciers can you count on Mount Rainier?_____

2) What is the name of the largest glacier? _____

3) Which four glaciers appear to be the smallest?_____

_____

4) Name five glaciers which appear to begin at the summit: _____

_____

5) Name five glaciers which appear to begin on the slopes down the mountain from the summit:_____

_____

6) Name two glaciers on the south side of the mountain: _____

_____

7) Generally, are the largest glaciers on the north side of the mountain or the south? _____ Why might this be? _____

8) Which glacier appears to extend the farthest down valley from the summit of Mount Rainier? _____

9) Pick one of the glaciers and research the origin of its name.

10) Create your own question on Mount Rainier's glaciers for your classmates to answer.

Galloping Glaciers

Subjects
science

Skills
experimenting
observation
compare/contrast

Materials

Session One

• glossy cards (e.g. postcards), about 10-12

• paper weight or other flat bottomed weight

• smooth board

Session Two

• ice cubes (of equal size), 2 per group

• bricks, 1 per group

• aluminum pie plate, 2 per group

Vocabulary
basal slip
plastic deformation

Learner Outcome

Students will be able to explain the two ways a glacier moves.

Background

There are two ways in which a glacier moves. One way is by plastic deformation and the other way is by basal slip.

A glacier does not move as one solid mass. Instead, ice below 100 feet within a glacier acts like a plastic in that it will bend and deform. It is able to do this because of constant rearrangement and regrowth of ice crystals due to the great pressure from above.

Basal slip, the second way a glacier moves, is caused by the weight of the glacial ice compressing and heating the ice molecules on the bottom of the glacier. The resulting melt water under the glacier helps the ice to slide downhill.

The ratio between basal sliding (the sliding of ice along its bed) and deformation varies between glaciers. Experiments at the Nisqually Glacier showed that 5-20 percent of movement is due to deformation and the remainder is caused by basal sliding.

Procedure

Session One

1) Stack the cards at one end of the smooth board and place the paper weight on top of the pile. The layers of cards illustrate the compressed ice at the bottom of a glacier and the weight illustrates the pressure from the weight of the glacial ice on top.

2) Gently raise the end of the board with the cards until the weight slides down and off the end of the board. The cards should slide over each other down the board. The cards do not move downhill in a single mass, but instead spread out and move at different rates.

3) Explain to the students how this is similar to the plastic movement of a glacier, in which the ice crystals behave like a viscous fluid, such as molasses, instead of a solid mass.

Session Two

1) Have each group take two ice cubes of equal size and place one on each aluminum pie plate.
2) Place a brick, representing the weight of the glacial ice, on top of one of the ice cubes.
3) Observe which ice cube melts the fastest.
4) Explain to the students that the weight of the brick caused that ice cube to melt quicker because it compressed and heated the ice molecules on the bottom. This is similar to what happens at the bottom of a glacier. The resulting melt water under the glacier helps the glacier to slide downhill. The term for this is *basal slip*.

(adapted from "Creeping Ice" in Reader's Digest's *How the Earth Works*)

Glacier on the Move

Subjects
science
math
drama (extension)

Skills
graphing
experimenting
measuring
recording
following directions
data gathering
comparing
inferring
cooperative action (extension)

Materials
(for each group of 2-5 students)
- 1 oz concentrated shampoo
- masking tape
- 1 index card (4x6)
- 5 small circles of paper (punch size)
- 1 index card (3x5)
- clock (w/sweep second hand)
- pencil
- spoon (plastic)
- *Glacier on the Move* worksheet*

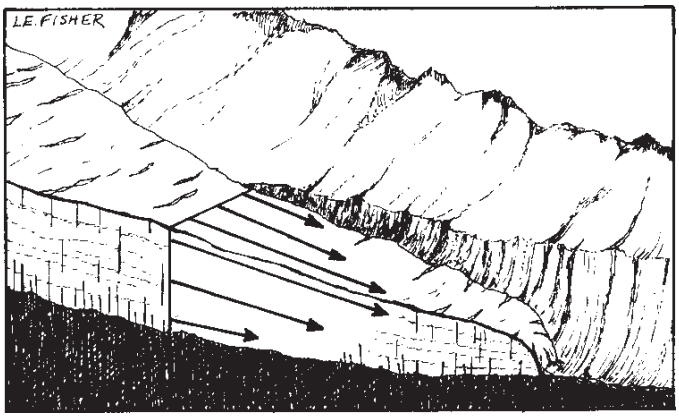
** provided*

Learner Outcome

Students will demonstrate an understanding of the surface motion of a glacier as it moves downhill.

Background

Velocities of glaciers vary considerably with ice thickness, temperature, slope, and season. On their surface, glaciers flow faster down the center and more slowly at the edges due to friction, like a river of water, as demonstrated in the activity *Run, River Run*.. The bottom of a glacier moves more slowly than the ice near the surface.



There are special techniques to record the velocity of a glacier. Surface velocities are determined by mapping the location of objects on a glacier from year to year. Rows of steel rods are put in directly across a glacier. The rods in the center will move farther downslope than those near the edges, making the row of stakes bowed.

Procedure

1) Have students follow the instructions on the "Glacier on the Move" worksheet and answer the questions.
2) Go over the results with the class.

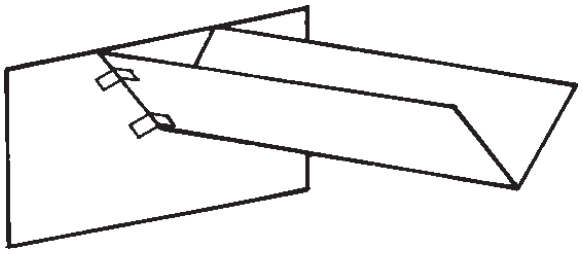
(from *Holt Earth Science Resource Book*)

Extensions

1) Students can act out glacial movement.
2) To demonstrate friction underneath a glacier take two blocks of ice, one plain and one loaded with gravel. Using a plank of wood create a slope and observe which ice block slides downhill faster.

Glaciers on the Move

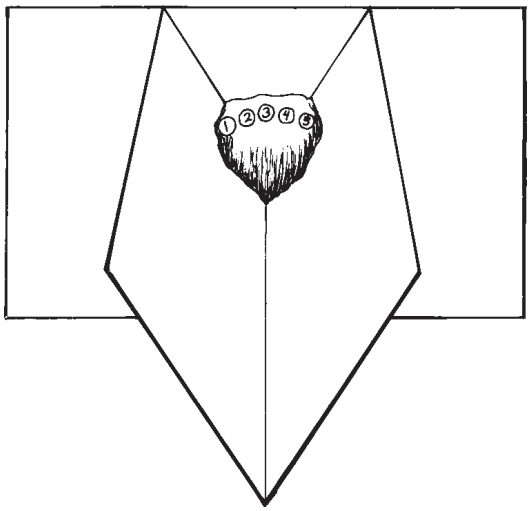
1) Prepare a V-shaped trough by folding a 4 x 6 index card lengthwise and taping it to a 3 x 5 index card as shown below. Add additional tape at the junction of the two cards so that the material placed in the V will not flow out through the crack.



2) Number five small circles of paper 1 through 5. Place these aside for later.

3) Holding the trough so the open end is up and the closed end forms a pocket, squeeze about 1 oz. of shampoo concentrate into the trough.

4) Continue to hold the trough so that no movement of the shampoo concentrate occurs while your partner lines up the 5 paper circles in order across the shampoo near the 3 x 5 card. If you dampen a finger, it will pick up the circles. You are going to watch the movement of the circles and mark on the side of the trough where each circle is at 15 second intervals. Move the circles around with your pencil to line them up.



5) Watch the clock and set the trough down on a given minute. Watch the motion of the circles as the shampoo moves. Every 15 seconds for 1 minute, write the number of each circle on the outside of the cardboard V to indicate the position of each circle. You will end up with 4 positions for each circle.

If something goes wrong, start over by holding the trough as before and pushing the shampoo back the way it was with your spoon. The circles can be sunk under the surface and new ones arranged as before.

6) Measure the distance each circle moved and record it in the following table.

	Distance Moved (mm)			
Circle	15 Sec.	30 Sec.	45 Sec.	60 Sec.
1				
2				
3				
4				
5				

7) On a separate sheet of paper, plot your data for each time interval on a graph with the following set of axes:

Horizontal Axis: Circle Number (1-5)
Vertical Axis: Distance Moved in Millimeters

Join all the 15 second positions of the circles with a smooth line going from left to right. Join all the 30 second positions, the 45 second positions, and the 60 second positions in the same way. These represent the kind of motion shown over time.

8) Answer the following questions:

Where did the shampoo move the fastest, outside or middle? _____

Where did the shampoo move the slowest, outside or middle? _____

If a glacier moves the same way as the shampoo did, which part of the glacier moves downhill fastest?

_____

Looking at a glacier, what evidence shows you which part is moving fastest?

_____

Why do you think the shampoo and glacier would move like this?

_____

Insulating Ice

Subjects
science
math

Skills
experimenting
predicting
graphing
data gathering
observing
compare/contrast

Materials
- clock
- ice cubes of equal size
- insulating materials (e.g. paper, foil, plastic wrap, wax paper, fabric and if possible, volcanic ash)

Vocabulary
accumulation
ablation
albedo
insulating

Learner Outcome

Students will demonstrate the effectiveness of various insulating materials and graph their results.

Background

Accumulation is the process by which a glacier is continually replenished with snow from precipitation, avalanches, and drifting of wind-blown snow. October to April is the accumulation season. It is the time when more snow accumulates than is melted. May to October is called the ablation season. This is the time when a glacier loses more snow and ice than is accumulated. Ablation is the process of wasting, by which ice and snow are lost from a glacier from melting or evaporation. The rate of ablation depends on the humidity and temperature of the air, the amount of solar radiation received, and albedo (reflectivity). Fresh snow has greater albedo than glacial ice, so glacial ice melts more quickly.

Because it absorbs radiation better, dark-colored rock debris on a glacier often becomes warmed more rapidly than the snow and ice. If the rock debris is thin enough (less than 6 inches thick) to be warmed through, it melts its way into the underlying ice and forms a hole. However, if the material is too thick (more than 6 inches thick), it acts as an insulator and protects the underlying ice leaving behind a rock "table."

Procedure

1) Students should first make predictions as to what kind of material would be most effective for insulating ice and what kind of material would be least effective.
2) Students then will conduct an experiment to determine the effectiveness of various insulating materials in keeping ice from melting. Try materials with different colors and thicknesses. (Note: Different thicknesses will affect the results of the experiment. Greater accuracy can be obtained by using covers as uniform in thickness as possible)
3) Having an uncovered ice cube as the "control", place it and the ice cubes wrapped in different insulators, in the sunshine if possible and time how long it takes for each to melt completely. Students will sequence the insulators in order of their effectiveness and can graph their results.

Extensions

Complete the experiment with ice and with snow, under equal conditions, and compare results. Or try using different thicknesses of the same material and observe what happens.

Giant Ice Scrapers

Subjects
science

Skills
experimenting
recording
observing
inferring
describing

Materials
(for each group of 2-5 students)

- water
- waxpaper
- sand and pea size gravel
- two cake pans, pie tins, or ice cube trays
- modeling clay or smooth piece of wood
- sandstone or shale samples (optional)

Vocabulary
glacial polish
glacial flour
striations
avalanche
cirque
tarn

Learner Outcome

Students will demonstrate the erosional effect of glaciers on the landscape.

Background

Glaciers erode the landscape by abrasion, quarrying (plucking), or pushing. If a glacier were composed of pure ice, it would not erode the landscape. A glacier is able to erode because of its "grit," rock material ranging in size from huge boulders to fine clay, which is embedded in the ice and carried downstream by the glacier. Very fine fragments embedded in a glacier polish the surface of the overridden rocks, like a huge emery board or piece of sandpaper, creating glacial polish and producing glacial flour. Large, coarse rock fragments in a glacier gouge grooves or striations in the bedrock.

The main sources of the rock debris transported by a glacier, such as the Nisqually, are avalanches and rockfalls from cliffs on the sides of the valley through which a glacier moves, onto the surface of the ice. Thawing and refreezing of the glacial ice incorporates this rock material into the ice and the glacier will then carry it along. The glaciers at Mount Rainier contain an unusually high volume of rocks due to the presence of very loose igneous rocks.

Another way a glacier picks up rock debris is through the expansion of water freezing in rock fractures in the bedrock under the glacier. This helps to loosen blocks of material. When the ice freezes to the rock and the glacier moves, the glacier will dislodge and pick up large fragments of the bedrock. This process is called plucking or quarrying. It allows the ice at the head of the glacier to scoop out a steep sided bowl into the mountainside called a cirque. The formation of these rounded depressions is also helped by frost wedging, a process in which rocks are broken apart by frost action. Cirques are found at the upper ends of alpine glaciers. At Mount Rainier some examples of cirques are the Willis Wall (cirque of the Carbon Glacier) and Sunset Amphitheater (cirque of the Puyallup Glacier). Cirque lakes or tarns form as glaciers melt away from these depressions. Examples at Mount Rainier are Lake George, Snow, Tipsoo, and Mowich Lakes.

Procedure

1) Cover the bottom of one pan (or tray) with a layer of sand and gravel; leave the other pan empty. Then fill both with water and freeze them. After they are frozen, remove the ice from the pans/trays.
2) Have students feel the bottom of the two different pieces of ice and record their observations.
3) Rub both pieces of ice, one at a time, bottom side down, across a piece of wood or clay that has been flattened out on some wax paper (or other suitable material). Have students record their descriptions of what each piece of ice does to the clay or wood. (Variation: Have students do step #3 using shale or sandstone instead of wood or clay.)
4) Ask which piece of ice is most like a glacier? Why? How does a glacier erode as it moves down a mountainside or across land? What do you think happens to the material that a glacier erodes?

(from "How Do Glaciers Erode Mountains" in North Cascades Institute's *Living With Mountains)*

Extensions

1) Let the ice melt, leaving behind glacial till.
2) Make a Moraine: Fill a small tray half full with sand and level it out. Then fill a zip-lock bag with water. Place the bag on the sand and push it along sideways. When you remove the bag you will see a terminal and lateral moraine. What shape are they? (In actuality, the "bulldozer effect" is only a secondary way that moraines are formed. The primary way is simply by rocks rolling off the convex top of advancing or relatively stable glaciers. Retreating glaciers loose their convex surface due to melting and thus, less moraine building occurs.) Next, repeat this procedure, but this time poke a hole in the bag and pull it in the opposite direction as if it were a retreating glacier. The water which flows out is like the melt water of a glacier. What happens to the moraine? (The water will create a channel and some of the moraine will be washed away) (from Reader's Digest's *How the Earth Works*)

Nature's Sculptors

Subjects
science
art

Skills
cooperative learning
artistic representation
compare/contrast

Materials
(for each group of 5 students)

- plaster of Paris
- 1 popsicle stick
- water
- 2 quart-sized milk cartons
- 1 small (about 2") piece of tagboard cut into a V
- 1 small (about 2") piece of tagboard cut into a U

Vocabulary
hanging valley

Learner Outcome

Students will differentiate between V-shaped river valleys and U-shaped glacial carved valleys.

Background

Glaciers usually do not create new valleys because they flow down already existing V-shaped stream valleys which offer the easiest course. As glaciers move through these stream valleys they modify them by deepening and widening them into U-shaped glacial troughs.

Before a glacier moves down a river valley there are tributary streams flowing into the main valley which normally join the mainstream at the same level as the mainstream. When a glacier moves down the main valley, however, the ice in the larger valley is usually thicker and capable of greater erosion than the smaller glaciers in tributary valleys. The main valleys will be carved more deeply and rapidly than the side-stream valleys. When the glaciers retreat they may leave a sharp discordance between the main valley and the tributary valley. This is called a hanging valley. Often waterfalls flow from hanging valleys.

Procedure

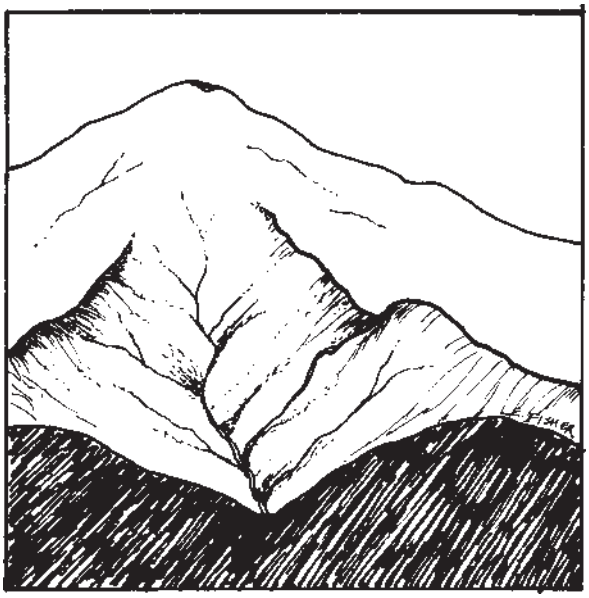
1) Discuss with the class how glaciers carve U-shaped valleys out of V-shaped valleys and how hanging valleys are formed. Tell the students they will be demonstrating this process in plaster.
2) Divide the students into groups of five.
3) Distribute two quart-sized milk cartons to each group. Have the groups cut out one long side of each carton. Fold down and tape the spout end of each carton flat. This should make an open, four-sided box.
4) Distribute plaster and water to each group.
5) Have the students mix half of the plaster in one carton and, using a small piece of tagboard cut into a V, drag the tagboard across the length of the carton, creating a V-shaped valley . Do not make the "valley" deeper than 1 inch. Using the popsicle stick, add some tributary valleys coming in from the side, the same depth as the main valley. This represents the landscape before a glacier.

6) Have the students now mix the other half of the plaster in the other carton and, using the same piece of tagboard cut into a V, shape a V-shaped valley the length of the carton as before. Again, make sure the valley is no deeper than 1 inch. Add the tributary valleys coming in from the side, the same depth as the main valley.

7) Now have the "glacier" move through this second valley. Before the plaster hardens, use a 2 inch piece of tagboard cut in the shape of a U to scoop out the V-shaped valley into a deeper U-shaped valley. Leave the side tributary valleys "hanging" above the level of the main valley. Gently shape the tributary valleys into shallow U-shaped valleys using the wide end of a popsicle stick.

8) Explain to the students that the second model represents the landscape after a glacier has carved out a stream valley. If taking a field trip to Mount Rainier National Park, tell the students they will be driving through the U-shaped valley which the Nisqually Glacier carved.

9) Students may want to paint their models after they have hardened.



V-Shaped River Valley

U-Shaped River Valley

Forward or Reverse?

Subjects
science
math

Skills
graphing
inferring
writing
interpreting

Materials
- graph paper
- *Paradise Snowfall and Nisqually Glacier Records**

** provided*

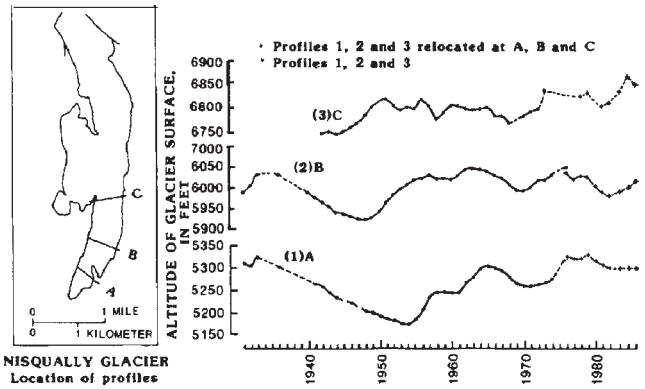
Vocabulary
terminus
glacial advance
glacial retreat
equilibrium line

Learner Outcome

Students will graph and make correlations between snowfall, glacial ice thickness and glacial advance and retreat.

Background

The Nisqually Glacier has been studied for many years. In 1857, August V. Kautz was the first European to visit the glacier. S.F. Emmons described it in a scientific paper in 1871 and John Muir measured the flow rate of the glacier in 1888. Since 1918 the terminus of the Nisqually Glacier has been measured on a regular basis; in 1931 Tacoma City Light began mapping the glacier terminus every five years and measuring the surface elevations of the Nisqually Glacier because they became concerned about the retreat of the glacier, the source of their water supply being collected in the newly constructed Alder Lake Reservoir.



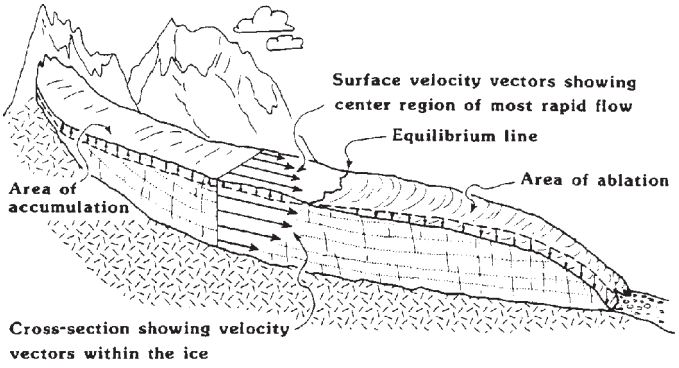
The ice surface has been surveyed from fixed points on the ridge above the glacier's eastern edge. The altitudes plotted on the graph are the average of each year. A rise in altitude of the profile appears in 1976 when the profiles were relocated slightly. (from *A Visitor's Guide to Mount Rainier Glaciers*)

What determines whether a glacier advances or retreats? If accumulation of snow exceeds ablation over a number of years, the glacier terminus advances. If ablation exceeds accumulation over a number of years, the glacier terminus retreats. Even when its terminus is retreating upvalley, the main body of the glacier continues to flow downvalley unless the ice is stagnant (as was the case with the Paradise Glacier).

There is a delicate balance between accumulation and melting, known as an equilibrium line. The equilibrium line (also called firnline) marks the limit on a mountain above which snow

persists from one winter to the next. The equilibrium line on most of Mount Rainier's glaciers is about 1950 meters (6,500 feet). Accumulation of ice and snow exceeds the amount lost by ablation in the zone of accumulation. Ice loss exceeds accumulation in the zone of ablation at the lower part of a glacier.

Glaciers react to climatic changes, and very small changes in air temperatures can have a major effect on the advance or retreat of a glacier. At Mount Rainier there is about a five to twenty year lag time between climatic stimulus and glacier response at the terminus (Note: the lag times are hypothetical). Each glacier's response is unique due to the glacier's length, shape, slope, elevation, and aspect on the mountain.



from *A Visitor's Guide to Mount Rainier Glaciers*, by Carolyn Driedger

Procedure

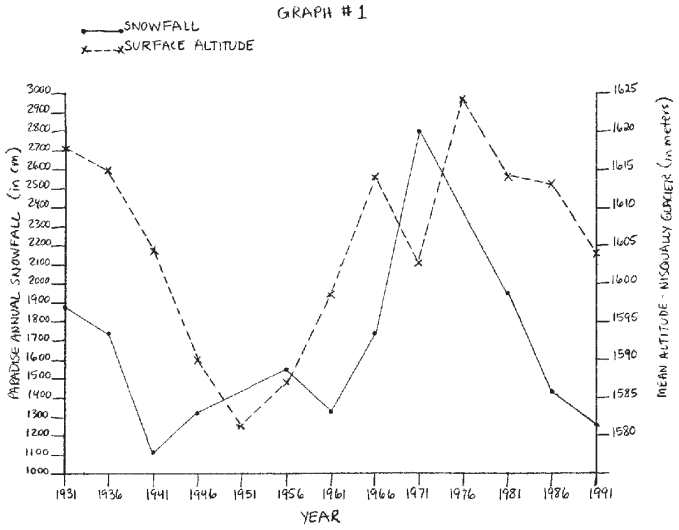
1) Using the data, students will prepare three graphs for the years 1931-1991 at five year intervals (see example below).

   Graph #1
   Horizontal Axis = Years
   Left Vertical Axis = Snowfall in Centimeters
   Right Vertical Axis = Mean Altitude of Nisqually Glacier Ice Surface in Meters

   Graph #2
   Horizontal Axis = Years
   Left Vertical Axis = Snowfall in Centimeters
   Right Vertical Axis = Distance of Nisqually Glacier Terminus from Glacier Bridge in Meters

   Graph #3
   Horizontal Axis = Years
   Left Vertical Axis = Mean Altitude of Nisqually Glacier Ice Surface in Meters
   Right Vertical Axis = Distance of Nisqually Glacier Terminus from Glacier Bridge in Meters

2) Have students study the graphs to note any correlations which might explain what makes a glacier advance or retreat and write a paragraph summarizing their observations and theories. (Note: These are somewhat simplified, hypothetical examples and not often used in actual glacier-climate research work.)



PARADISE WEATHER STATION
ANNUAL SNOWFALL RECORDS (1931-1991)

1931-32	1878 centimeters	1961-62	1363 cm
1936-37	1733 cm	1966-67	1730 cm
1941-42	1115 cm	1971-72	2805 cm
1946-47	1323 cm	1976-77	1035 cm
1951-52	*	1981-82	1948 cm
1956-57	1548 cm	1986-87	1435 cm
		1991-92	1248 cm

** records unavailable*

MEAN ALTITUDE OF NISQUALLY GLACIER ICE SURFACE

(at Profile 1, which is 550 meters up-glacier from the 1976 terminus)

1931	1618 meters	1966	1614 m
1936	1615 m	1971	1603 m
1941	1604 m	1976	1624 m
1946	1590 m	1981	1614 m
1951	1581 m	1985*	1613 m
1956	1587 m	1991	1604 m
1961	1598 m		

** 1986 data unavailable*

DISTANCE OF NISQUALLY GLACIER TERMINUS FROM GLACIER BRIDGE

1931	933 meters	1966	1700 m
1936	1046 m	1971	1734 m
1941	1175 m	1976	1639 m
1946	1292 m	1981	1793 m
1951	1422 m	1986	1775 m
1956	1518 m	1990*	1649 m
1961	1792 m		

** 1991 data unavailable*

Mapping the Snout

Subjects
science
math
art
physical education

Skills
measuring
cooperative action
inferring
map reading
comparing
data interpretation
questioning

Materials
- rulers (metric)
- *Mapping the Snout* outline map and worksheet*
- *Nisqually Glacier USGS Map, 1976**
- twenty two 8 1/2 x 11" signs with the year written on both sides (for Session 3)
- *Glacier Flip Book* page*

** provided*

Vocabulary
Pleistocene
moraine
trimline

Learner Outcome

Students will map the advance and retreat of the Nisqually Glacier and state the relationship between weather patterns and terminus movement.

Background

Mount Rainier has been covered with glaciers ever since it began growing nearly a million years ago during the Pleistocene or Ice Age. At times these glaciers were smaller than they are now, perhaps leaving the mountain completely bare of ice, and at other times larger, burying the entire peak in ice.

In the Nisqually River valley the furthest known glacial advance occurred 35,000 to 50,000 years ago. This "ancestor" of the Nisqually Glacier flowed as far as today's Alder Lake Dam, about 48 kilometers (30 miles) from its source. It was 540 meters (over 1,600 feet) thick at the site of the present town of Elbe! The last major glacial advance was 25,000 - 15,000 years ago when the Nisqually's ancestor extended down valley to the vicinity of today's community of Ashford.

Between about 8,000 and 4,000 years ago, the climate warmed and the glaciers shrank to smaller sizes than they are today. From about 3,000 years ago to the year 1840, the "Little Ice Age" took place and the glaciers on Mount Rainier again advanced. In 1840, the Nisqually Glacier extended 260 meters (900 feet) below the present Glacier Bridge. Almost all of the glaciers on Mount Rainier, including the Nisqually, slowly decreased in size after 1840 and by 1950 glaciers on Mount Rainier covered only about 2/3 of the area that had been covered in ice only 100 years before.

Since the 1840s the Nisqually Glacier has been making smaller scale advances and retreats. In the 1930s it retreated dramatically, while in the 1940s it advanced. From the 1960s to the early 1970s it was in retreat, then in 1976 it began to advance again. From 1981 until 1983 the terminus maintained its location, and then between 1984 and 1990 the terminus retreated 126 meters (440 feet). Today the Nisqually continues to retreat slowly.

Geologists have a number of ways of determining the former extent of the Nisqually and other glaciers. They study the size and age of moraines, the piles of loose rock at the glacial margins, and scratches in bedrock far downvalley from present day glaciers. The moraines are dated by measuring the age of volcanic ash on their surfaces and by taking core samples of

trees (to determine the age of the oldest trees). Trimlines, the boundaries between older and younger forest, or between forest and younger shrubby vegetation, also allow geologists to measure the past extent of glaciers in the valleys.

Procedure

Sessions 1 & 2

Distribute the "Mapping the Snout" worksheet to the students and have them work in teams to complete it. Be sure to have students complete parts A and B of the worksheet before showing them the USGS Nisqually Glacier map. (Note: The terminus measurements in part A will not match those in the previous activity "Forward or Reverse?" because the USGS map is based on an average of the five year cycle.)

Answers to Part B

1) 1840; 260 meters
2) 1951; 2600 meters
3) Retreated; advanced
4) From 1966 to 1974 it retreated 60 meters upvalley. Then from 1974 to 1976 it advanced 80 meters downvalley.
5) 290 meters
6) 670 meters
7) 1946-1951; 1350 meters; warmer summers and lower snowfalls; 1936-1941
8) 1951-1956; 470 meters; cooler summers and higher snowfalls; 1941-1946
9) Advance; between the years 2000 and 2010

Answers to Part C

1) 10 meters
2) The difference in elevation between each contour line
3) White
4) Brown
5) Green
6) Soil/rock; The glacier only recently retreated from that area, so there hasn't been enough time for vegetation to begin growing
7) Answers will vary.

Session 3

Take the class out to the school yard to demonstrate on a large scale the advance and retreat of the Nisqually Glacier which the students just mapped.

Using chalk, draw a line on the pavement at one end of the school yard (about 30 feet from the end of the yard) to represent the Glacier Bridge. Line the students up along this point. Explain to the students that they will be walking together, shoulder to shoulder with arms linked, as if they were the terminus of the Nisqually Glacier, to track the advance and retreat of the glacier from 1840 to 1976. To advance they will walk forwards. To retreat they will walk backwards. To measure the distances they will be counting their steps, with one small step equaling ten meters. At each terminus location leave behind one or two students (depending on the size of your class) from the end of the line, holding a sign indicating the year the terminus was at that spot. By the end of this activity all of the students in the class, each holding a sign for their year, will be spread out along the yard representing the advance and retreat of the Nisqually Glacier.

Begin by having the class face "downvalley" toward the nearest end of the yard and advance to the 1840 terminus location of the Nisqually Glacier. Since the glacier was 260 meters below the present Glacier Bridge, the students will take 26 small steps. Have one or two students remain at this point holding the 1840 sign. This point is the farthest "downvalley" location of the Nisqually.

Now, have the rest of the class retreat "upvalley" toward the chalk outline bridge. They will be retreating to the 1857 terminus location, which was 30 meters upvalley from the bridge. Have the students back up the 26 small steps to the "bridge," then continue to back up an additional 3 steps upvalley from the bridge (representing the 30 meters). Leave one or two students behind at this point holding the 1857 sign.

From here, the class will retreat to the 1870 terminus location, which was 140 meters upvalley from the 1857 location. Have the students back up upvalley 14 small steps and leave one or two students behind holding the 1870 sign.

Continue on as follows, leaving behind at each point one or two students from the end of the line with a sign indicating the year. (The glacier is retreating when it is moving upvalley and advancing when it is moving downvalley.):

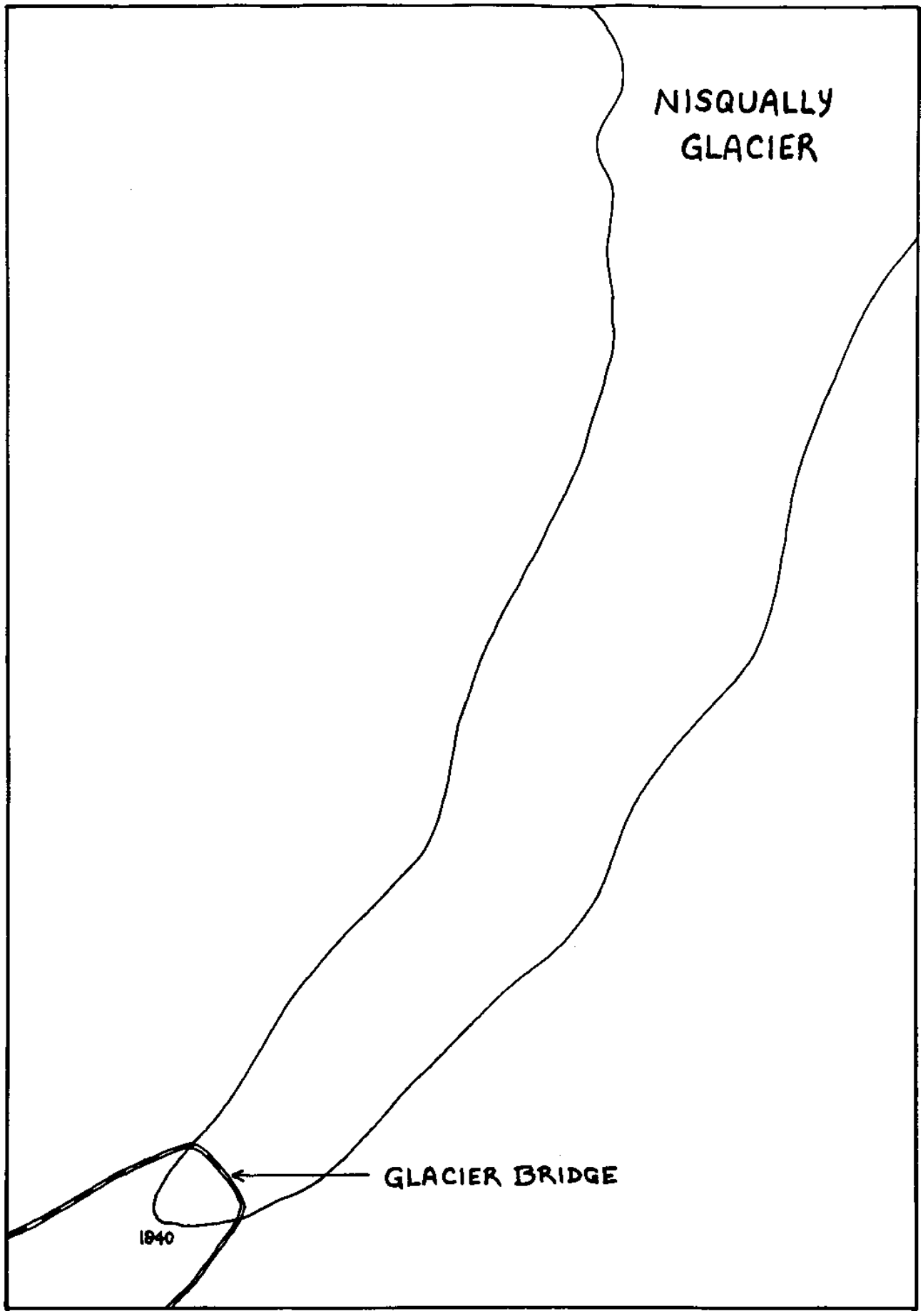
Year they are starting from	*Take this number of steps*	*Go this direction*	*Year they'll reach*
1870	3	Upvalley	1885
1885	4	Upvalley	1892
1892	7	Upvalley	1895
1895	16	Upvalley	1905
1905	3	Upvalley	1910
1910	14	Upvalley	1918
1918	6	Upvalley	1921
1921	12	Upvalley	1926
1926	9	Upvalley	1931
1931	10	Upvalley	1936
1936	13	Upvalley	1941
1941	11	Upvalley	1946
1946	135	Upvalley	1951
1951	47	Downvalley	1956
1956	29	Downvalley	1961
1961	9	Downvalley	1966
1966	1	Upvalley	1971
1971	5	Upvalley	1974
1974	8	Downvalley	1976

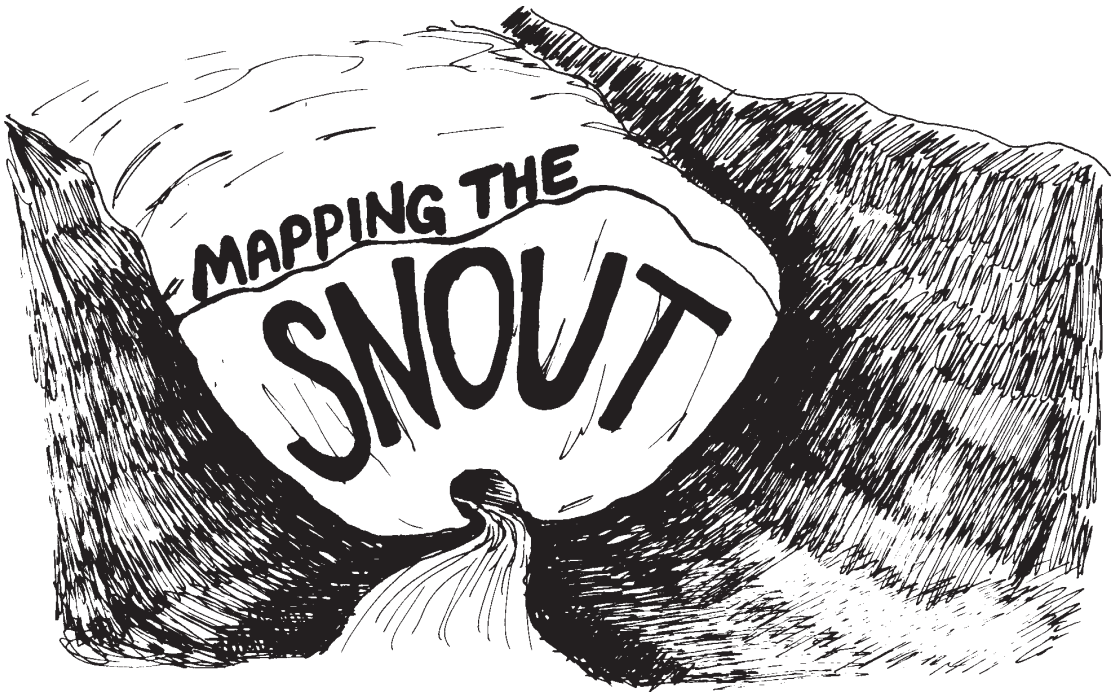
Once the students are all dispersed, have them hold up their signs indicating their year so that they may all see the movement of the Nisqually Glacier over the years. Then gather the students together and discuss with them the continual advance and retreat of the Nisqually and how glaciers react to climatic conditions, i.e. snowfall amounts and summer temperatures. Tell the students that they will be seeing the actual route which the Nisqually Glacier traveled when they go on the field trip to Mount Rainier.

Session 4

Now, flip out with a flip book of a glacier on the move!

1) Give each student six 4x6 index cards and a copy of the flip book (page 81). Cut the index cards in half to make 12 smaller cards. Each card should be exactly the same size so measure before cutting!
2) Cut out the pictures and glue each one to the bottom right-hand corner of each card.
3) Stack the cards on top of each other, in numerical order with #1 on the top and #12 on the bottom. Staple them together along the left-hand side.
4) Flip through the cards and make your glacier advance and retreat!


NISQUALLY
GLACIER
GLACIER BRIDGE
1940



PART A

Using the following information, plot the terminus of the Nisqually Glacier on the outline map by drawing a small (5 mm) line and writing the year next to it. Measure all distances from the present day Glacier Bridge shown on the map. Use the scale of 1 centimeter = 158 meters to determine distances. It will be easier if you convert all the meters into centimeters before measuring, by dividing by 158. The mark already shown on the worksheet (260 meters downvalley from Glacier Bridge) is from 1840. All other marks should be made upvalley from Glacier Bridge.

1857	30 m	*1936*	1010 m
1870	170 m	*1941*	1140 m
1885	200 m	*1946*	1250 m
1892	240 m	*1951*	2600 m
1895	310 m	*1956*	2130 m
1905	470 m	*1961*	1840 m
1910	500 m	*1966*	1750 m
1918	640 m	*1971*	1760 m
1921	700 m	*1974*	1810 m
1926	820 m	*1976*	1730 m
1931	910 m		

PART B

Answer the following questions based upon the terminus locations you just plotted on the map:

1) During which year was the Nisqually Glacier most advanced? _____

   How far downvalley from the Glacier Bridge was it in that year? _____

2) During which year had the glacier retreated farthest up valley? _____
How far upvalley from the Glacier Bridge was it in that year? _____

3) Between 1840 and 1951 did the glacier advance or retreat? _____
How about between 1951 and 1966?_____

4) What did the glacier do from 1966 to 1976? _____

_____

_____

5) How many meters did the Nisqually Glacier retreat between 1840 and 1857?

_____

6) How many meters did the Nisqually Glacier retreat between 1857 and 1921?

_____

7) During which five year span since 1921 did the glacier retreat the farthest?
_____ How many meters did it retreat? _____
What might be the reason for this rapid retreat?_____

_____

If there is a ten year gap between weather patterns and glacier activity, when might the weather pattern having caused this retreat occurred?

_____

8) During which five year span since 1921 did the glacier advance the farthest?
_____ How many meters did it advance? _____
What might be the reason for this rapid advance?_____

_____

If there is a ten year gap between weather patterns and glacier activity, when might the weather pattern having caused this advance occurred?

_____

9) If the 1990s have a higher than average snowfall and cooler than average summer temperatures what would you expect the Nisqually Glacier to do?

_____

During what years do you predict the glacier will react to this weather pattern?

_____

PART C

Compare the map on which you plotted the glacier terminus locations with the 1976 USGS Nisqually Glacier map. Now answer these questions:

1) How many meters is the contour interval on the USGS map?_____

2) What does “contour interval” mean? _____

_____

3) What color represents ice and snow on this map?_____

4) What color represents soil/rock on this map?_____

5) What color represents vegetation on this map? _____

6) What is directly downvalley from the glacier terminus: soil/rock or vegetation?

_____Why do you think that is? _____

_____

7) Create your own question on the Nisqually Glacier map to ask your classmates. _____

_____

_____

1
2
3
4
5
6
7
8
9
10
11
12

Yoke-Ull-What??!!

Subjects
science
language arts

Skills
creative writing
sharing
imagining

Materials
- *Great Nisqually Jokulhlaup* sheet*
- pencil

** provided*

Vocabulary
jokulhlaup

Learner Outcome

Students will be able to describe what a jokulhlaup is and write a story about being caught in a one at Mount Rainier.

Background

Glaciers are riddled with channels and spaces that are filled with liquid water. Sometimes there is a sudden release of this trapped water causing a glacial outburst flood, also called by its Icelandic name, jokulhlaup (yo-kul-hloips). Jokulhlaups may originate when a great amount of water from intense rainfall or from many warm, sunny days is stored in ice-dammed lakes or cavities within or underneath the glacier ice, and then is suddenly released when the "dam" breaks. Jokulhlaups are most common on the Nisqually, Kautz, South Tahoma, and Winthrop Glaciers. They have happened on other glaciers, but the volume is less.

When these jokulhlaups occur they may cause debris or mudflows which flow rapidly down the steep, glacially carved valleys from the glacier where they originate. Traveling 10-20 miles per hour or more, they look like wet concrete and are composed of churning masses of water, rock, mud, and broken trees. Their snouts, which are full of boulders, can be 30-60 feet high. They come to rest after about 30-60 minutes, leaving behind them splintered trees, picnic sites buried in mud, and damaged roads.

People who have witnessed these debris flows at Mount Rainier report that only 1-2 minutes may pass between the time the roaring sound of an approaching debris flow is heard and the time the flow rushes past. The deafening noise, which sounds like a locomotive, is often accompanied by strong local winds, thick dust clouds, and violent ground shaking.

The Nisqually River has experienced jokulhlaups from the Nisqually Glacier which damaged or destroyed the former bridge in the 1920s and 30s. The present bridge, built 198 m further downstream in 1957, was undamaged by more jokulhlaups in 1968, 1970, 1972 and 1985.

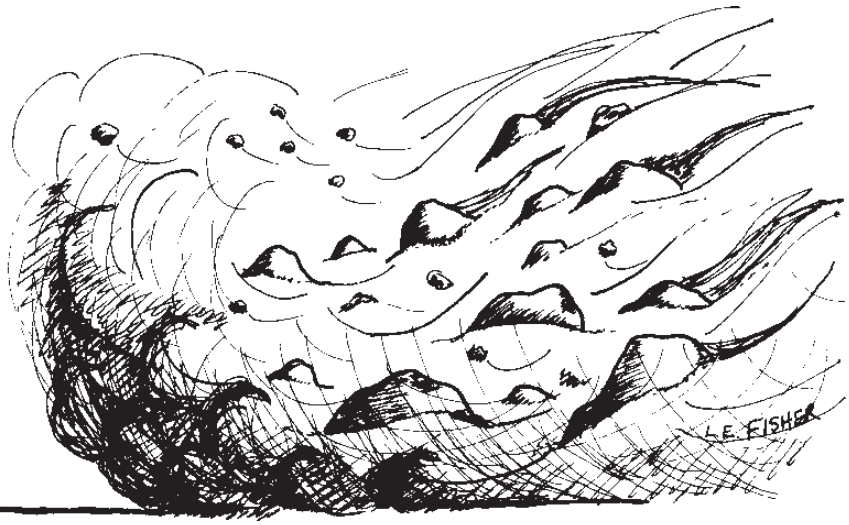
Kautz Creek had the largest debris flow since the park was established. On October 2-3, 1947, torrentially heavy rains triggered a jokulhlaup from the Kautz Glacier. Five and a half miles downstream the road was buried by 35 feet of mud and debris and boulders up to 13 feet in diameter. Smaller debris flows have moved along Kautz Creek in 1961, 1985 and 1986.

At least 20 debris flows have moved down Tahoma Creek since 1967, including one every year from 1986 through 1991. Debris flows have buried a picnic area and destroyed the lowest part of the Tahoma Creek Trail, and continue to damage the Westside Road.

Procedure

1) Hold a discussion with the students about jokulhlaups (yo-kul-hloips).
2) Tell the students they are going to pretend that they have been caught in a jokulhlaup at Mount Rainier. Have them imagine that they are on a peaceful hike in the forest of Mount Rainier when suddenly they hear the roaring, deafening sound of an approaching locomotive. They feel the ground shaking violently and notice a strong wind sweeping down the valley carrying a thick cloud of dust. It's a jokulhlaup!!
3) Now, have the students write a story describing their experience in "The Great Nisqually Jokulhlaup."
4) Have the students share their stories with their classmates.

THE GREAT NISQUALLY JOKULHLAUP



Land Use and the National Park Idea

"Thousands of tired, nerve-shaken, over civilized people are beginning to find out that going to the mountains is going home; that wilderness is a necessity; that mountain parks and reservations are useful not only as fountains of timber and irrigating rivers, but as fountains of life." – *John Muir*

Mountain Readings

Subjects
communications
language arts
social studies

Skills
reading
creative writing
valuing

Materials

- *Indian Wisdom Stories**
- Readings on John Muir and Fay Fuller*
- Worksheets to accompany the readings*
- Muir songsheet (see Post-Trip activities)*

** provided*

Vocabulary
(included on worksheets)

Learner Outcome

Students will gain an understanding of the relationship people from the past had with Mount Rainier and express their own feelings about the mountain.

Procedure

Have students read the passages, then complete the activities following the readings. (You may wish to go over the vocabulary words beforehand.) Or divide students into smaller groups, with each group being responsible for reading one passage and sharing it with the rest of the class. If you would prefer, assign the readings over the course of the school year; combine with additional stories, readings and related activities.

Some Words About Indian Legends

Indian history is oral history, carried down through the ages by stories that were told and retold until they were memorized. Legends of the traditional people could be divided into several categories including "the historical legends" believed to be basically true, "the how and why legends" that attempt to explain a natural activity and "the fantasy stories" in which animals take on human aspects and can work magic on others. The stories could be told and retold by anyone in the tribe though the task of storytelling was usually left up to the grandparents, the elders of the tribe. Probably the most favored stories dealt with the spirit forces who were good, bad, or both. Not only were these stories entertaining, but each one taught a valuable lesson.

(from *Where the Waters Begin* by Cecelia Carpenter)

Answers to the Indian Stories Questions

1) That they may use the bridge as long as they are at peace; if they become greedy and selfish, the bridge will be destroyed.
2) The people forgot the Great Spirit's message and started fighting.
3) Answers will vary.
4) One side of the river would flow up the mountains and the other side would flow down.
5) Because the salmon would have no place to stop and spawn.
6) No one knows for sure; it's instinct; they use their sense of smell.
7) Clothing, houses, baskets, canoes; was used to make a rope.
8) To turn into a beaver and to make the trees small enough to carry
9) Answers will vary.
10) Elkhorn; to chisel steps in the snow.
11) Swam and washed himself in the lake; spent the night there.
12) Jokulhlaups (glacial outburst floods)
13) Answers will vary. Before the Indians were created, the world was inhabited by a race of animal people. They were larger than today's animals and they could talk and do everything else that people do today.
14) The Snow brothers; moisture condensing in high clouds and precipitating as snow.
15) Mouse; by chewing through the bows of four of the brothers so only one was still able to bring snow.
16) Answers will vary, e.g. to teach, entertain, to pass on oral history, to record
17) Answers will vary, e.g. involve nature, decision-making
18) Answers will vary, e.g. lived in harmony with nature; respected nature; tried to win the favor and protection of the spirits

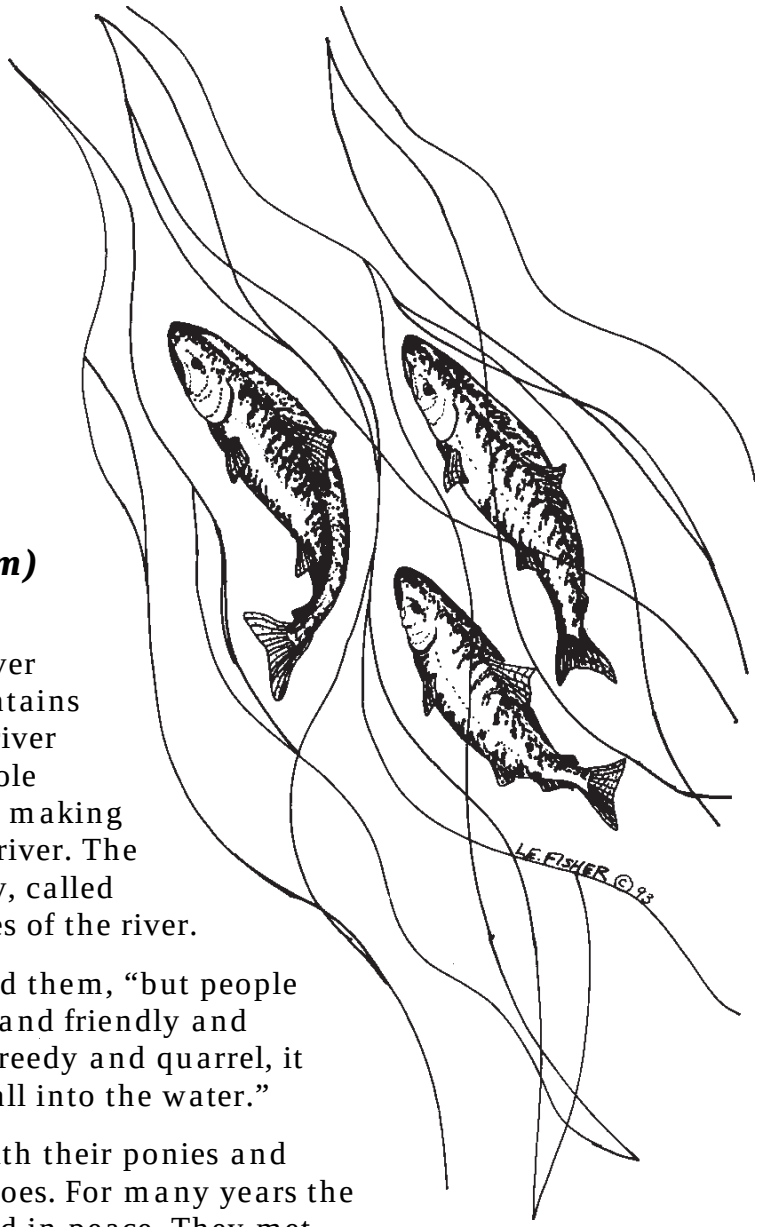
Answers to the John Muir Questions

1) Scotland
2) Sciences
3) An accident temporarily blinded him.
4) Logging of Giant Sequoias; sheep overgrazing the meadows. He wrote newspaper and magazine articles calling for the establishment of Yosemite and Sequoia National Parks.
5) 1888; 50
6) Climb to their summits; his quote about being on the summit of Mount Rainier tells us so.
7) 1899
8) He wrote about them and helped convince Congress to make them national parks.
9) No; People saw wilderness as something to be conquered and tamed.
10) 76
11) Answers will vary

Answers to the Fay Fuller Questions

1) 1890; 20
2) School teacher
3) Two days; two days
4) Today's food is more light weight and more varied; often freeze dried. Fay's party took all cold food. Today's climbers use their backpacking stoves to cook their food.
5) Flannel bloomer suit, heavy calfskin boy's shoes, loose blouse with many pockets, straw hat, woolen hose, warm mittens and goggles; People thought her clothes were immodest and unladylike.
6) A crater with steam vents and ice caves.
7) The party arrived at the summit too late in the afternoon to head back down that day.
8) Answers will vary
9) Answers will vary between high, rocky ledges, icy slopes, crevasses, snow storms, cold, intense sun, etc.
10) Through her newspaper articles which brought publicity to Mount Rainier.

Indian Wisdom Stories



Retold from *Indian Legends of the Pacific Northwest* and *Mythology of Southern Puget Sound*

THE RIVER SPIRIT AND THE MOUNTAIN DEMONS (Wishram)

Long ago, there was a lot of fighting between the spirit that lived in the river and the spirits that lived in the mountains above it. After one battle, the angry river spirit used all his powers and cut a hole then dug a tunnel through the rocks, making a wide natural stone bridge over the river. The Great Spirit, whose home is in the sky, called together the tribes living on both sides of the river.

"This is a bridge of the spirits," he told them, "but people may cross it as long as you are good and friendly and peaceful. If you become selfish and greedy and quarrel, it will be destroyed and the rocks will fall into the water."

The people crossed over the bridge with their ponies and dogs and passed under it in their canoes. For many years the Indians on both sides of the river lived in peace. They met together to fish and hunt and pick huckleberries, for games and races, potlatches and dances. But after several generations the tribes began quarreling and one day there was a war over who owned the bridge.

Suddenly, the earth began to shake and tremble. The mountain demons belched flaming thunderbolts and hurled hot stones and liquid rocks upon the water below. The river spirit dashed waves against the bridge supports. The huge rocks rumbled and then, with the sound of thunder, the bridge collapsed. Rocks, earth, and trees came tumbling down into the angry, whirling river. The water began to rise as if a dam had broken loose.

The bridge fell because the people had forgotten the words of the Great Spirit and peace between the tribes had been broken. The Indians were punished for their actions. When all the tribes are at peace again and smoke the pipe of friendship, another bridge will be built across the river.

WHY RIVERS FLOW ONE WAY (Snohomish)

Long ago, all the animal people came together for a big meeting. Eagle, high up in the tallest tree, was in charge of the meeting. Each of the animal people at the meeting had a chance to say what they thought. For a long time the people argued about what direction the rivers should flow. Should they flow up or down, or both directions? Everyone but Raven thought that one side of all rivers should run up the mountains and the other side should run down. When the rivers got as far as the falls, they would turn around and come back.

"What do think of our plan?" they asked Raven, who was known to be wise.

"I don't agree with you," replied Raven. "If the rivers turn around at the falls, salmon will have no chance to stop. Instead they will have to come right back again and where will they spawn? I think all rivers should go one way. And I think that all the bends in the streams should have little eddies to make the salmon go slower. Then people can fish there."

"Raven's reasons sound very good," said Eagle. And everybody agreed. That is why all rivers run only one way. And that is why the salmon go up to their home river to spawn.

THE ORIGIN OF THE FORESTS (Snoqualmie)

Long ago, Moon was chief of the heavens. One day he said to Spider, "Make a rope of cedar bark and stretch it from the earth to the sky."

Soon Fox and Blue Jay found the rope and climbed up it. When they came to the end of the rope, Blue Jay pecked a hole in the sky and the two of them crawled through it.

Blue Jay flew to a tree and Fox found a lake where she changed herself into Beaver. Beaver got caught in a trap that Moon had set. The next morning Moon took Beaver out of the trap and threw her into the smokehouse. That night when Moon was asleep, Beaver escaped.

Outside, she found a great forest of fir and pine and cedar trees. She pulled some of them up by the roots and with her spirit powers, made them small enough to carry under one arm. She found the sun hidden behind Moon's house, wrapped it up in leaves and bark and carried it under her other arm.

Then Beaver found the hole Blue Jay had made and changed herself back to Fox again and went down the rope to the earth. She put the sun in its place so it would give light and heat to all and she planted all the trees. The trees which Fox brought down from the sky and planted became the giant forests of the Cascade Mountains.

By now, Moon had awakened and when he discovered the beaver had gone and the sun had disappeared from its hiding place, he was very angry. He followed Beaver's footprints to the top of the rope. But as he started down to the earth, the rope broke and Moon fell down in a heap where it was transformed into a mountain.

A YOUNG MAN'S ASCENT OF MOUNT RAINIER (Puyallup)

This is a story about a young man who was looking for magical power. He made five spearpoints of elkhorn and went to the mountain, Ta-co-bed (Mount Rainier), and began to climb up over the snow. He used the elkhorn spears to chisel steps in the snow and ice. As each one wore out, he would throw it away and use another.

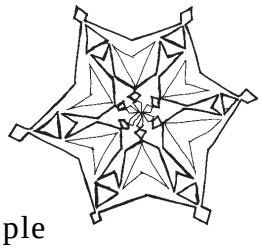
He finally reached the top of the mountain and found a lake. He swam and washed himself in the lake and stayed the night on the mountain top. From this experience he gained magical power and the mountain spoke to him. "You will grow to be an old, old man," she said. "Moss will grow on your elbows and knees. Your hair will fall out and you will die of old age. When you die, my head will burst open and the water you now see in the lake will flow down the mountainsides."

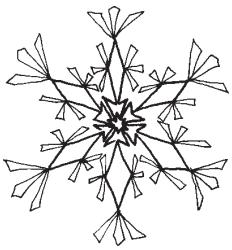
As the man started down the mountain, he picked up five pearl shells he had found. It immediately began snowing. The mountain does not wish me to take these shells, he thought. He threw them down and it stopped snowing.

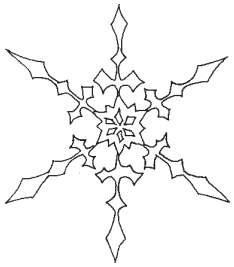
The young man grew old; his hair fell out. He grew very old. Moss appeared on his head, knees and elbows. He told his people to look at Ta-co-bed when he dies. "Her head will break open and water will come pouring out." he warned.

The man died and just as he predicted, the mountain top burst open; water rushed down the hillsides and swept away the trees in the valley, leaving a covering of porous rocks. Today there is no longer a lake on the top of Ta-co-bed; it has spilled out.

THE BATTLE WITH SNOW (Chehalis)







Long ago, during the days of the animal people, snow was sent by the five Snow brothers. One winter they sent so much that all the houses in the village were buried. The people had to make tunnels under the snow to get around. There was so much snow and the winter was so long that the animal people began to worry about starving to death.

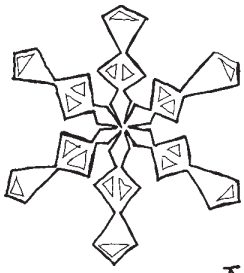
The chief said they would have to fight the Snow brothers and the people agreed. When spring came, the chief told his people, "We will have to go north to where Snow lives, before winter comes."

Early that autumn they prepared for their journey. They traveled on land for three days and by air for two days until they arrived at the Sky World, where they soon found the house of Snow.

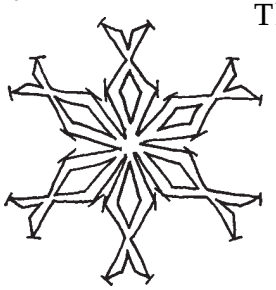
"We will attack early in the morning," announced the chief.

During the night, Mouse sneaked into Snow's house. She went to the bow of the oldest Snow brother and chewed it to shreds. Then she went to the second, third and fourth brothers' bows and did the same thing. Daybreak came and she had to leave

before she had time to cut the fifth brother's bow but she was satisfied. She hurried back to her people and told them what she had done.



Early in the morning the animal people attacked Snow's house. The five brothers jumped up to get their bows and arrows but only the youngest one could use his bow. The others had been chewed through. Mouse had done her work well. The brothers soon gave up and fled to the north.



Thus the Snows were beaten. That is why we have little snow today. If Mouse had not cut the four bows, we would still have deep snows. Now only the youngest brother brings the snow.

Indian Wisdom Stories

After reading the Indian Wisdom Stories, complete these activities.

Story Questions

Answer each question in a complete sentence on a separate sheet of paper.

The River Spirit and Mountain Demons

1) What message did the Great Spirit give the people?
2) Why did the bridge collapse?
3) Do you think we are ready for another bridge to be built – why or why not?

Why Rivers Flow One Way

4) What was the first plan proposed for the rivers?
5) Why did Raven disagree with this plan?
6) Why do salmon return to their river of birth? How do you think they find the right river?

The Origin of the Forests

7) The native people in this area used cedar trees for many things. Name some of the ways they were used. How was cedar used in this story?
8) How did Fox use her spirit powers?
9) Fox brought back the sun to the people. What other gifts from the sky are you grateful for?

A Young Man's Ascent of Mount Rainier

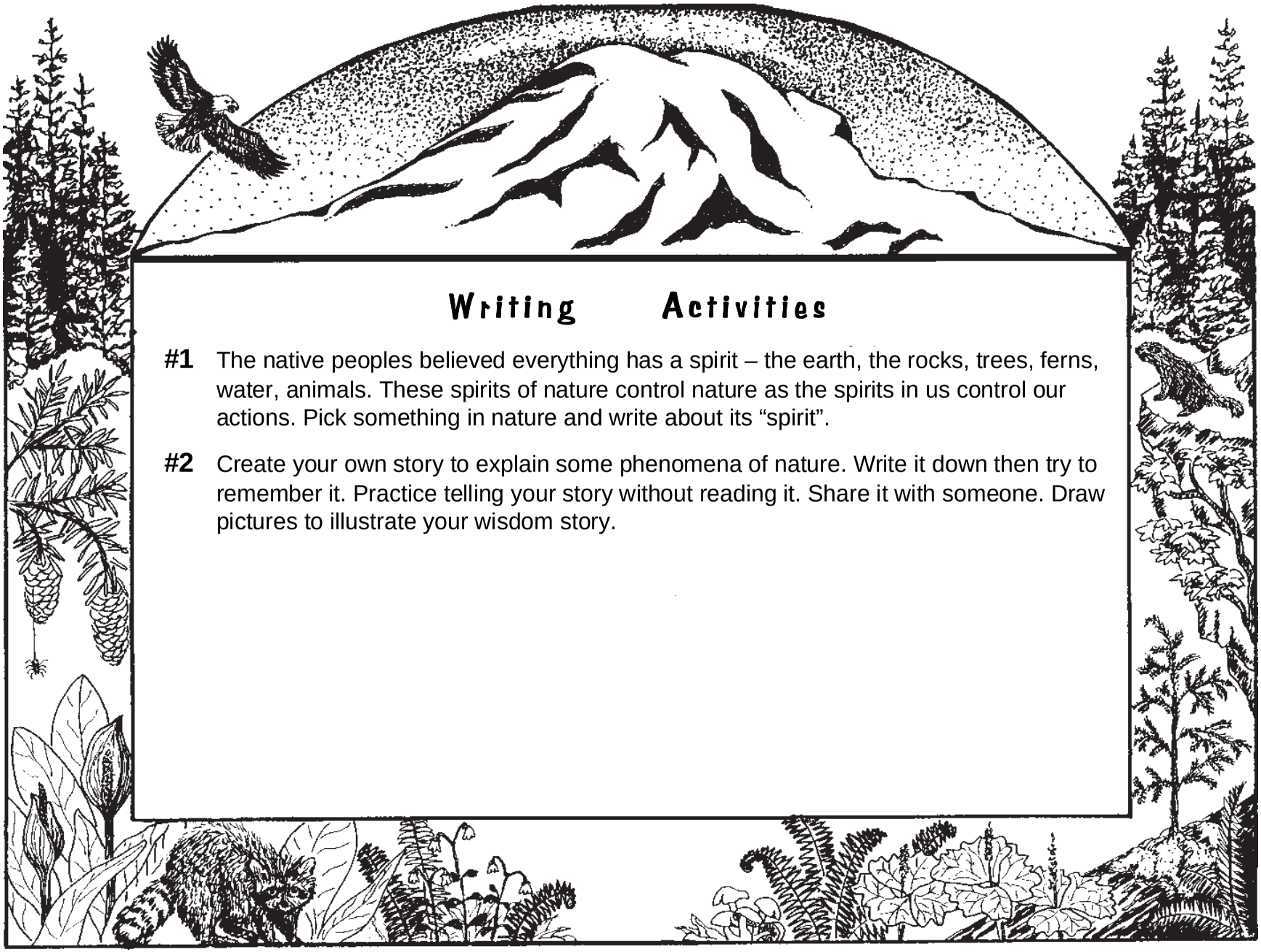
10) What did the man make his spearpoints out of? How were they used?
11) What did he do when he got to the top of Ta-co-bed?
12) What geologic event is similar to that described in the story?

The Battle with Snow

13) Who do you think the animal people are?
14) What was responsible for snow in this story? What explanation do we give today?
15) Who was the hero of the story? How did she help make the winters less severe?

Overall Questions

16) What purpose do these wisdom stories serve?
17) What do these stories have in common?
18) What was the Indians' relation to nature?



Writing Activities

#1 The native peoples believed everything has a spirit – the earth, the rocks, trees, ferns, water, animals. These spirits of nature control nature as the spirits in us control our actions. Pick something in nature and write about its “spirit”.

#2 Create your own story to explain some phenomena of nature. Write it down then try to remember it. Practice telling your story without reading it. Share it with someone. Draw pictures to illustrate your wisdom story.

JOHN MUIR
Spokesman for the Parks

"Out of the forest at last there stood the mountain, wholly unveiled, awful in bulk and majesty, filling all the view like a separate, newborn world, yet withal so fine and beautiful it might well fire the dullest observer to desperate enthusiasm. Long we gazed in silent admiration, buried in tall daisies and anemones by the side of a snowbank."

So wrote naturalist, mountaineer and philosopher, John Muir at Alta Vista in Paradise, at the start of his climb of Mount Rainier in 1888. The next day, he and his party climbed another four thousand feet, making camp at a spot now known as Camp Muir. Later, in a letter to his wife, Louie Wanda, Muir said, *"Did not mean to climb it, but got excited and soon was on top."* In fact, John Muir was perhaps the greatest mountain climber in all of the United States, if not the entire world, during the latter half of the last century. *"The mountains are calling me and I must go..."*

Born in Scotland in 1838, John Muir immigrated with his family to Wisconsin in 1849. Muir spent years there, toiling at Fountain Lake Farm, eighty acres of stumps and rocks. After leaving home, he studied the sciences at the University of Wisconsin. During his spare time he invented labor saving machines and took many geological and botanical hikes. Upon leaving the university, he went to work as an inventor at a broom handle factory, where an accident temporarily blinded him. In despair, Muir lamented that he never again would see "*...the sunshine and the wind in all the gardens of God."* Muir spent a month of uncertainty in darkness before his vision slowly began to recover. It was during this time that Muir vowed that if his sight should ever return he would devote his life not to the inventions of people, but to "the *study of the inventions of God."*

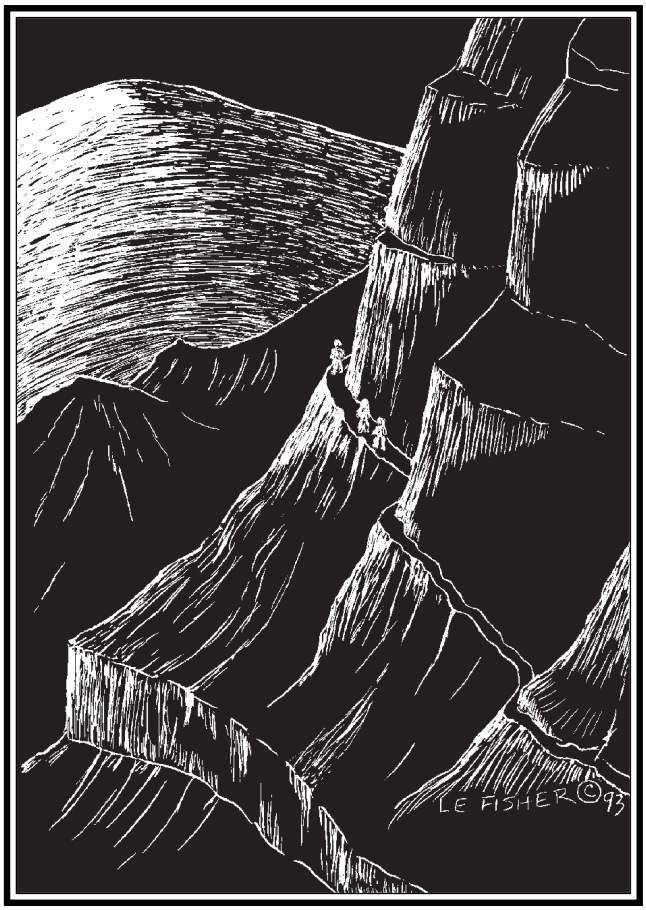
In 1867, just after the Civil War, his sight having returned, Muir turned his back on the city and began a life of wanderings through the American wilderness. His first journey was a thousand mile walk to the Gulf of Mexico, taking the *"wildest, leafiest, and least trodden way"* he could find. In 1868 John Muir came to the Sierra Nevada mountains of California. He spent the next ten years exploring the canyons and peaks around Yosemite, studying the plants and glaciers. In his wanderings he found much destruction taking place. The fragile high meadows of wildflowers were being grazed by sheep, *"hoofed locusts"* he called them, until they were bare. Thousand-year-old Giant Sequoia trees, no good for lumber, were being cut to make fenceposts, shingles, and grapevine stakes. This outraged Muir and spurred him to write newspaper and magazine articles calling for the establishment of Yosemite and Sequoia National Parks. *"Wildness is a necessity,"* he wrote, *". . . mountain parks and reservations are useful not only as fountains of timber and irrigating rivers, but as fountains of life."* These were very rare words spoken during a time when the wilderness represented something to be tamed and conquered.

In 1888 Muir's eyes turned toward the Cascades, and one of its most priceless gems, Mount Rainier, *". . . the most majestic solitary mountain I had ever beheld."* In August, with a party of eleven other men, including artist William Keith, P.B. Van Trump, and Major E.S. Ingraham, Muir started on an expedition to be the third party to ever climb Mount Rainier. On their way up the Nisqually River to Paradise Valley the whole party got food poisoning. Not knowing what it was, they ate more tainted food! *"There was poison and sickness in every pot,"* said Muir.

In spite of this, they continued on, and soon the excitement of being close to the mountain made them forget their pains. To Muir, Paradise was *"the most luxuriant and most extravagantly beautiful of all the Alpine gardens"* upon which he had ever laid his eyes. On August 14th Muir and six members of the party began making their way to the summit. They set up a high camp at ten thousand feet on a ridge between the Nisqually and Cowlitz Glaciers originally called "Cloud Camp" and renamed "Camp Muir" by party member Ingraham. Since the party did not bring blankets they built a wall of rocks to block the blowing sand and ash. The next morning at 4:00 a.m. they set out from their base camp and were standing on the summit by 11:45 a.m. After spending two hours on top, Muir saw signs of an approaching storm and hurried the party down. The next day Muir wrote of the climb:

"The view which we enjoyed from the summit could hardly be surpassed in sublimity and grandeur; but one feels far from home so high in the sky, so much so that one is inclined to guess that, apart from the acquisition of knowledge and the exhilaration of climbing, more pleasure is to be found at the foot of the mountains than on their frozen tops. Doubly happy, however, is the man to whom lofty mountaintops are within reach, for the lights that shine there illuminate all that lies below."

In such writing, Mount Rainier and many other of today's national parks found a powerful, yet gentle champion for their preservation. During the latter part of the 1800's the idea of national parks was new; only a few existed (today there are 50 plus over 300 other National Park Service units). In a nation still consumed with fighting the last Indian wars and settling the remaining frontier, the idea of setting aside land for its scenic value and to preserve it in a wild state was considered frivolous and wasteful by many people. It was only through the voice of John Muir and other like-minded visionaries that the national parks captured the imagination of the public, thus saving them from destruction.



Old Gibraltar Trail

In 1894 a bill was introduced into Congress to create a national park at Mount Rainier. In 1899 the act creating Mount Rainier National Park was finally passed by Congress and signed by President McKinley.

Until his death in 1914, Muir continued his travels and writing to bring about other national parks, including Grand Canyon and Petrified Forest, as well as to inspire people in other nations to preserve wild areas. He also was one of the persons responsible for the 1906 Antiquities Act, which gives Presidents the power to create national monuments.

Today, as urban areas expand and rural areas shrink, the park and wilderness lands which John Muir helped to preserve are becoming more and more priceless. Increasing numbers of people are beginning to realize this, and are now discovering the truth in the words of John Muir:

"Everybody needs Beauty as well as bread, places to play in and pray in, where Nature may heal and cheer and give strength to body and soul alike."

JOHN MUIR

After reading "John Muir: Spokesman For the Parks," complete the following activities.

Vocabulary

Look up the meanings of the following words used in the article on John Muir. Then write a sentence for each word. (If the word has more than one meaning use the same meaning as the one used in the article.)

sublimity	**withal**	**trodden**	**luxuriant**
extravagantly	**surpassed**	**awful**	**grandeur**
prose	**acquisition**	**illuminate**	**lofty**
visionaries	**frivolous**	**exhilaration**	**spurred**

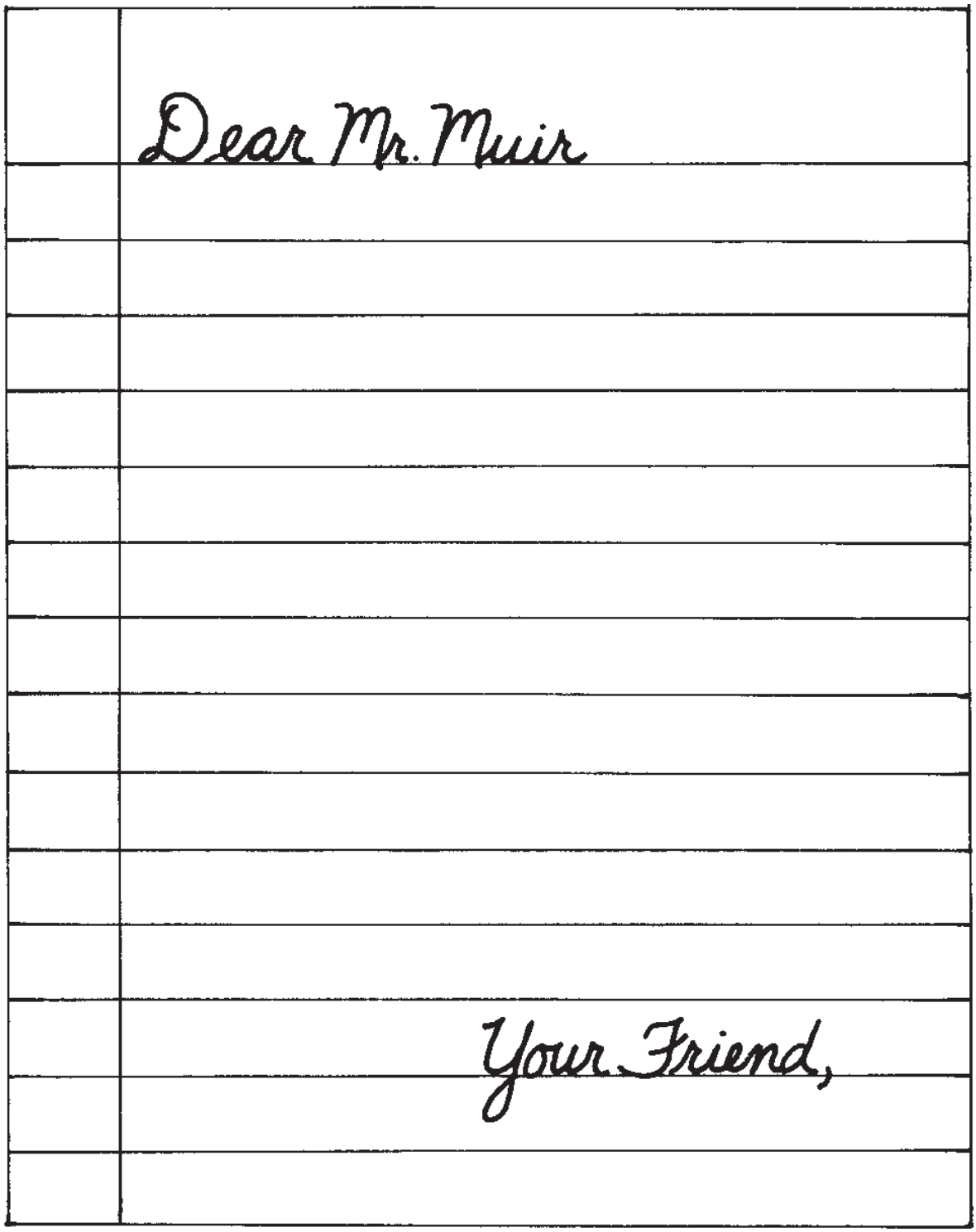
Reading Questions

Answer each in a complete sentence on a separate sheet of paper.

1) Where was John Muir born?
2) What did John Muir study at the University of Wisconsin?
3) What event made John Muir turn away from inventing things and turn toward studying nature?
4) What destruction did John Muir find taking place in the Sierra Nevada? What did he do to stop this destruction? What would you have done?
5) In what year did John Muir climb Mount Rainier? How old was he?
6) Do you think John Muir preferred to stay at the base of mountains or climb to their summits? Why do you think so?
7) When did Mount Rainier become a national park?
8) How did John Muir help Mount Rainier and other national parks?
9) Do you think many people in the 1800s felt the way John Muir did about nature and wilderness? Why do you think so?
10) How old was John Muir when he died?
11) Explain what John Muir meant when he wrote, *"Everybody needs Beauty as well as bread, places to play in and pray in, where Nature may heal and cheer and give strength to body and soul alike."* Do you agree or disagree? Why?

Writing Activity

Pretend it is possible to send a letter back in time to John Muir in the year 1900. Write him a letter thanking him for saving so much of our American wilderness so we can enjoy it now, almost 100 years later. Tell him how you think we are taking care of our natural world today, and how you, yourself, are helping to do so.



FAY FULLER
Mount Tahoma's Famous First Female

In 1890 an event took place at Mount Rainier which attracted nationwide attention. On August 10th of that year the first woman climbed Mount Rainier. She was a twenty year old school teacher by the name of Miss Fay Fuller.

Fay, who lived west of the mountain in the town of Yelm, had wanted to stand on the summit of that mighty peak ever since she met P.B. Van Trump, one of the first two persons to climb Mount Rainier. Her chance finally arrived in August of 1890 when she was invited to join Van Trump and his family on a visit to Mount Rainier. She excitedly went along, hoping that she would be able to join one of the two parties that was going to be climbing while she was at the mountain.

It took two days to ride horseback from Yelm to the Paradise Valley, where they made camp with several other parties. At Paradise, Fay shared her enthusiasm and determination to climb the mountain with the Seattle climbing party already assembled there, and was soon invited to join the group on their climb. There were four members of the party which consisted of their guide, Reverend E.C. Smith; R.R. Parrish, W.O. Amsden, a photographer; and Leonard Longmire, grandson of the founder of the Longmire Mineral Springs.

On the morning of August ninth they set off for Camp Muir, with a food supply of corned beef sandwiches, cheese, chocolate, dried beef, fried ham, hard boiled eggs, sardines, bread and butter, extract of beef, dried peaches, raisins and prunes.

Fay shocked everyone and was made a laughing stock because of her "immodest and unlady-like" clothes, which included "a *thick blue flannel bloomer suit, heavy calfskin boy's shoes, loose blouse ... with innumerable pockets in the lining and a small straw hat in order to get the benefit of the sun."* People were also shocked that she rode horseback like a man, instead of side-saddle.

The party spent the night at Camp Muir at 10,000 feet, and the next morning arose at 4:30 a.m. to begin the ascent. Before starting, Fay *"... donned heavy flannels, woolen hose, warm mittens and goggles,"* blackened her face *"with charcoal to modify the sun's glare, drove long caulks and brads"* into her shoes, *"rolled two single blankets containing provisions for three days and strapped them from the shoulder under the arm to the waist, by far the easiest way to carry a pack, shouldered one of Uncle Sam's canteens,"* grasped her alpenstock and headed off. She was *"resolved to climb until exhausted."* When the four men on the climb offered Fay assistance over some difficult areas, she declined, saying that she wanted to get up there on her own power or not at all!

When the party reached the Gibraltar ledge, the most dangerous part of the climb, they roped themselves together and used their alpenstocks (long poles with a spike on

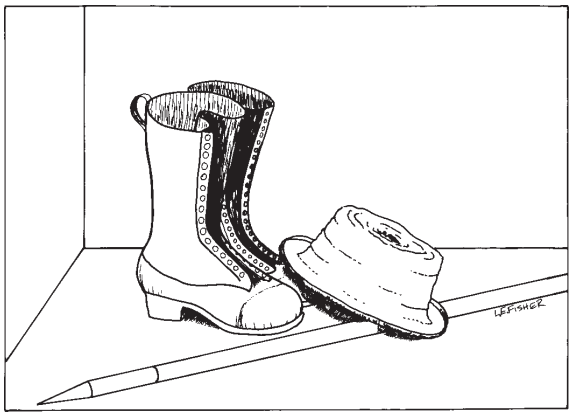
the end) to keep themselves from slipping. Fay stated in an article she later wrote, *"Gibraltar is the rocky cliff about 1000 feet high which blocks the passage to the summit of the mountain. For half a mile the route lies around that cliff on a shelf along the edge with that great wall above you and the Nisqually Glacier stretching away miles below. If this shelf, scarcely three feet wide, were only level, it would make the traveling much easier, but it slants down towards the glacier and is composed of nothing but loose sand and rock. In crossing one unusually ticklish place Mr. Parrish's bundle, which he had taken off to throw over first, went whirling through space down, down the glacier out of sight. Only one wrong step and that would be the end of all. When the ridge was almost passed we found we had a steep glacial side of solid ice to climb for about fifty feet, and then, tied with ropes, our guide cut steps with a hatchet and we waited, one step only firmly planted, for step after step to be cut out. Already the sun was melting the snow and the rocks came down to our right and left, Mr. Smith being hit twice but able to keep his footing."*

Fay's party also traversed across the glaciers. *"The first crevasse we came to,"* she wrote, *"was not very large and over it we found a good though narrow bridge where we stood and got the first look inside the mountain. Bluish green ice walls on either side of a big crack look like caves running up the mountain sides. Some are large enough to drop a house into and one seemed bottomless."*

Despite the wind and extreme cold, all five in the party made it to the summit of Mount Rainier at 4:30 on the afternoon of August 10, 1890. Fay describes the view as, *"a wonderful panorama."* She said the day was clear and that they could see, *"Adams, Hood, St. Helens and Jefferson, Mount Baker to the north and miles of mountains forming one great circle round the horizon. The glaciers of the Nisqually, Cowlitz, Carbon and White Rivers were seen, and the valleys and prairies beyond."*

They spent a short time on the summit looking at the view then decided to take refuge in the crater. With only a few blankets for protection against the cold, the party spent the night in an ice cave. There were steam vents in the crater which to Fay looked, *"as if a row of boiling tea kettles had been placed along the ridge. We sat on the rocks and were soon damp with the moisture and parboiled by the heat..."*

Fay slept little, and the following morning at 6:30 the party began their decent back to Paradise Valley. The descent was in the middle of a bad snow storm with winds so strong that many could hardly stand up, but they all made it back safely that day. However, Fay states that both herself and the guide, *"were pitiable sights. Our lips, noses and almost all of our faces were swollen out of proportion, eyes sore and wrists peeling and for several days the pain was intense."*



Upon returning to Yelm, Fay Fuller wrote articles about her ascent of the mountain. Published in her father's newspaper these articles inspired others to become interested in the sport of mountaineering and heightened the developing interest in Mount Rainier. More and more people began calling for the area to be made into a national park, and on March 2, 1899 it became our nation's fifth national park.

After reading "Fay Fuller: Mount Tahoma's Famous First Female," complete the following activities.

Vocabulary

Look up the meanings of the following words used in the article on Fay Fuller. Then write a sentence for each word. (If the word has more than one meaning use the same meaning as the one used in the article.)

determination	**donned**	**resolved**	**panorama**
bloomer	**flannels**	**declined**	**pitiable**
innumerable	**provisions**	**alpenstock**	**hose**
immodest	**brads**	**traversed**	

Questions on the Reading

Answer each in a complete sentence on a separate sheet of paper.

1) In what year did Fay make her famous ascent and how old was she?
2) What was Fay's profession?
3) How long a journey was it from Yelm to Paradise and from Paradise to the summit?
4) How was the food Fay's group brought with them on the climb different from food climbers bring to Mount Rainier today? What would you bring to eat if you were going to climb the mountain?
5) Describe Fay's clothing for the climb. Why were people shocked by these clothes?
6) What did the climbers find on the summit?
7) Why do you think the climbing party spent the night on the summit?
8) Why do you think Fay was so determined to climb Mount Rainier?
9) What do you think was the greatest danger on Fay's climb?
10) How did Fay help with the establishment of Mount Rainier National Park?

Writing Activity

Pretend you are a reporter for famous Fay Fuller's father's newspaper in 1890. Write either a news article telling about the first woman to reach the summit of Mount Rainier or write an editorial expressing your opinion on whether or not the Mount Rainier area should be made into a national park.

Tahoma Times

Who Owns the Forests?

Subjects
social studies
art
geography

Skills
discussion
drawing
sharing
compare/contrast
categorizing

Materials
- drawing paper
- forest use picture cards*
- *Nisqually River Basin Map**
- Washington State road map

** provided*

Learner Outcome

Students will understand that the forests of the Nisqually River basin are owned by different groups and individuals and are managed for various purposes.

Background

Over half of Mount Rainier National Park is covered with forest, administered by the National Park Service. National parks preserve forests and other areas for the education, enjoyment, and inspiration of all people.

Who owns the forests outside of Mount Rainier National Park? They are administered by several public and private groups, each with a different purpose or management strategy.

Owner	*Management Strategy*
Public	
• National Park Service (Mount Rainier N.P).	Preservation – recreation, research, wilderness, wildlife
• U.S. Forest Service (Gifford Pinchot N.F.) (Mt. Baker-Snoqualmie N.F.) (Wenatchee N.F.)	Multiple Use – timber, range, wildlife, recreation, wilderness
• Indian Tribes	Tribal choice
• WA Dept. of Natural Resources	Timber harvest, wildlife and recreation
• WA Parks & Recreation	Recreation and wildlife
• Counties and Cities	Recreation and wildlife
Private	
• Private Industry	Timber harvest, recreation, wildlife
• Private Individuals	Individual choice

Other Forest Owners

State Parks
Operated by the Washington Parks and Recreation Commission, the state parks offer a variety of recreational opportunities such as camping, boating, picnicking, swimming, horseback riding, environmental learning centers, winter recreation and fishing. Hunting is not allowed.

County and City Parks
Most county and city parks are for day use only and have no charge. They range from high use playground and picnic facilities to undeveloped natural areas. Special public events are sometimes held at these parks.

Public Utility Lands
These hydrodam areas are managed for hydroelectric power while also providing for fishery programs – hatcheries, stocking, and flow regimes – and wildlife management, both hunting and habitat enhancement. Swimming, boating, picnicking, camping, mushroom picking and photography are other popular activities.

Military Land
The Department of Defense manages its lands for many different purposes from wildlife habitat to golf courses. Priority is given to military maneuvers. Many areas are open to the public, using a permit system. Bird watching, picnicking, hunting and fishing are permitted. Overnight camping is not allowed.

Procedure

1) Have a class discussion on what the students like to do in the forest. Then have each student draw a picture of the activity they enjoy doing in the forest (e.g. hiking, fishing, looking for signs of wildlife or downhill skiing). Have students share their pictures and discuss the differences in types of forests required for each activity.
2) Discuss the fact that many different groups, both private and public, administer the forests in the Nisqually River basin. Show students the forest use picture cards and explain who each owner is and how each forest is managed (see information on back of pictures). Then ask students which forest would best suit the activity that they shared in their drawing. Conclude by having students write a caption to go with their pictures. For example: "I could go on a picnic in a national park and see some spectacular scenery" or "I could go skiing at a ski resort that leases land from the U.S. Forest Service."
3) Using the Nisqually River Basin Map along with a state road map, have students identify who owns the land between their school and Mount Rainier. Devise a key with symbols for timber harvesting, recreation, preservation, wildlife, cattle ranging, and other uses and draw or display appropriate symbols on the appropriate section of the Basin Map.

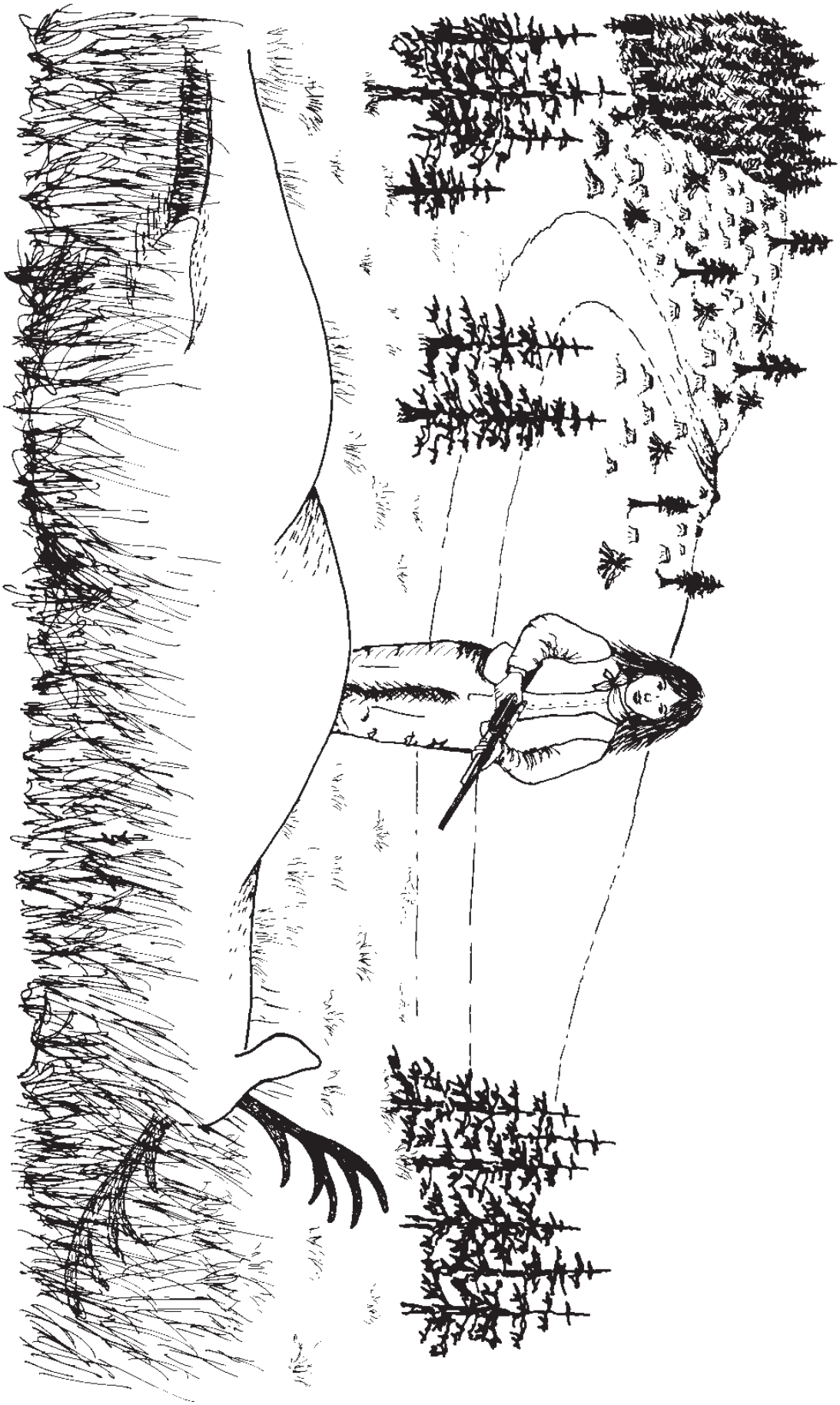
(adapted from "Who Owns Washington's Forests?" in *Forests of Washington: Forest Ecosystems and People, Activity Guide Grades 4-9)*

Extension

1) Take a field trip to Mount Rainier National Park and on the way look for different uses of forested areas. Discuss how they are managed for different purposes. Compare how they look and the types of jobs they provide. Compare what opportunities each area offers for people in the Nisqually River basin.

WHO OWNS THE FORESTS?
National Park Service

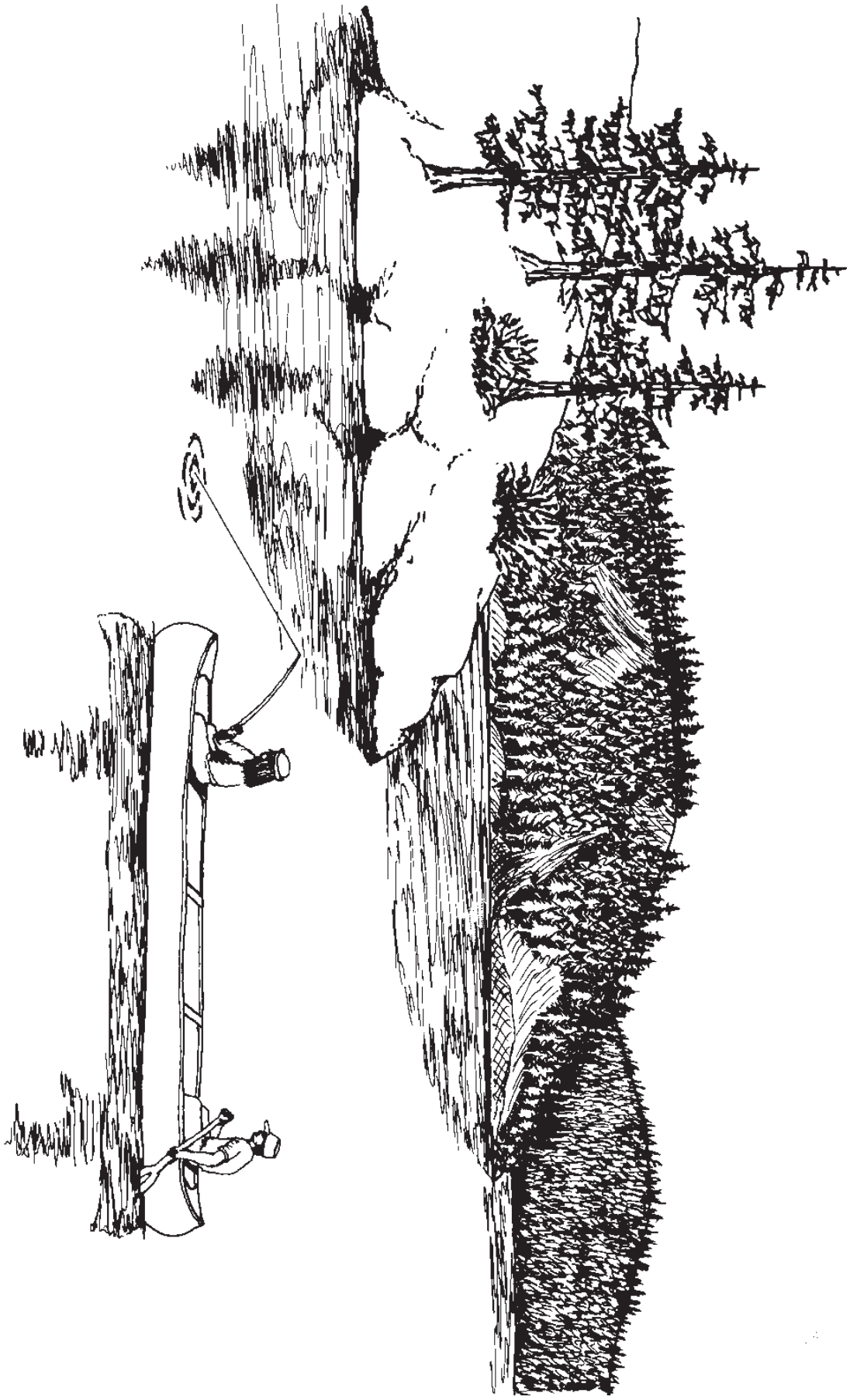
National parks and monuments are owned by the public and managed by the Department of Interior of the U.S. government. These areas are preserved because of their outstanding beauty, history and/or ecological value. The park resources are to be enjoyed by the public without being destroyed. Activities most commonly found in such areas are hiking, picnicking, sight-seeing, photography, camping and cross-country skiing. Hunting, cutting firewood, and collecting of any kind, are not permitted.



WHO OWNS THE FORESTS?

United States Forest Service

The national forests are owned by the public and managed by the Department of Agriculture of the U.S. government. These areas are set aside for multiple uses such as timber sales, wildlife management, grazing and recreation. Some national forests also include wilderness areas that are off limits to roads and vehicles. The Forest Service can issue permits to ranchers, ski resorts, mines and other commercial operations. Recreational activities allowed in most national forests include hunting, fishing, camping, boating, swimming, hiking, and picnicking.



WHO OWNS THE FORESTS?

Department of Natural Resources

The Washington State Department of Natural Resources (DNR) is required by the state to manage their forests for timber production. Revenues from timber harvesting are to used to help fund school buildings and other public facilities. Public activities include camping, hunting, grazing, fishing, etc.

WHO OWNS THE FORESTS?

Private Industry

The main activity in forests owned by private industries is usually timber production which provides for people's daily demand for wood products. While trees are being regrown and in different stages of succession, this land is used extensively by a variety of wildlife including deer, elk and birds of prey. People also use commercial forests for hunting and other recreational activities such as hiking, horseback riding, fishing and mountain biking. One should check with the company owner before using for specific regulations and closed areas.

Managing the Land

Subjects
social studies
communications

Skills
research
interviewing
discussion
oral presentation
compare/contrast
valuing

Materials
reference materials

Learner Outcome

Students will be able to describe different philosophies of land management.

Procedure

1) Divide the class into six groups, one group for each of the following:

   National Park Service
   U.S. Forest Service
   Sierra Club
   Nisqually Indian Tribe
   Mountain Ski Resort
   Forest Products, Inc.

2) Ask each group to devise a goal statement and five management guidelines for the same parcel of land from a different viewpoint. Explain to the students that a goal statement is what the group is trying to accomplish with the land, for example, preserving it for future generations, creating a commercial venture, developing a recreation area, or using it as an educational facility. Management guidelines, on the other hand, are the ways they are going to accomplish their goal and the regulations they will follow to do so, for example, to preserve the land for future generations they would not allow anyone to collect or remove any of the natural features and there would be restrictions on development. If the group wanted to use the land commercially they would set certain fees and develop the area. The parcel of land in question is a watershed the size of the city of Seattle. One third of the area has snow covered peaks and two thirds of it is covered with old-growth forest. There is a large river with several tributaries flowing through it.

3) To assist the students in understanding the goals of each interest group encourage them to read advertisements, brochures, magazine articles, and books related to their group. They may also wish to contact local representatives of similar businesses and agencies. Groups should take into account economic and social aspects of their guidelines, as well as the impact on the resource as a result of their plan.

4) When the groups have completed their assignments, have them share their goal and guidelines with the class. Then discuss the following questions:
   - How are the goals and guidelines of the various groups different? How are they similar?
   - What other types of groups might represent different goals and guidelines?
   - What values does each group attach to the land? How are these values reflected in their land management plan?
   - What are the similarities and differences between publicly and privately managed land? Do they influence each other?
   - How do your goals and guidelines affect the community at large?

Extensions

1) Select a real parcel of land in your community and have students apply their group's guidelines to this area.
2) Have students select a government agency and research its goals and how it operates.
3) Have a discussion on the difference between preservation and conservation. Both are concerned with protecting the resource. The National Park Service practices preservation in that it attempts to keep the resources safe from any kind of abuse or damage through nonconsumptive uses and values. The Fish and Wildlife Service practices conservation which uses the resource in both nonconsumptive and consumptive ways, within limitations so that the resources will last for the future.

(adapted from "Ownership Objectives" in *Project Learning Tree, Activity Guide 7-12*)

National Park Resources: What If We Run Out?

Subjects
social studies
science
physical education

Skills
cooperative action
discussion
following directions
problem solving

Materials
- animal name tags (one per child)
- masking tape
- container (for collecting cards between rounds)
- a large open area or playing field
- rope or twine (at least 15 yds.)
- resource cards (a different color for each resource: water, food, shelter)
- code of ethics certificates (optional)*

** provided*

Vocabulary
extinction
extirpation
habitat

Learner Outcome

Students will be able to describe the consequences of shrinking resources and the role of parks in preserving resources. They will identify at least three ways they can help preserve a park's resources.

Background

As more and more resources are used by humans, there are less and less available for wild things – land, plants, and animals. Nature reserves, wilderness areas and national parks like Mount Rainier become increasingly important as living laboratories, recreation spots and sanctuaries from our busy lives.

With encroaching development, parks become increasingly isolated, functioning like natural "islands" in a "sea" of urbanization. In recent years, scientists have become concerned that these "islands" may not be enough for the survival of some wilderness resources. Throughout the National Park System, parks are beginning to work with their neighbors to help protect the natural resources outside the park boundaries.

At most parks, such as Mount Rainier, the park staff works diligently with private landowners, other government agencies, and concerned individuals to protect land around the park while still allowing for human development. Cooperative management may hold the key to protecting not only Mount Rainier itself, but also wilderness areas throughout the region.

Procedure

Make enough resource cards to play four rounds. For the first round make one card of each resource for each child i.e. each student will have three different colored cards. For each of the next three rounds, subtract six from the original number of cards e.g. if you start out with 30 of each color for Round One, Round Two = 24 cards, Round Three = 18, and Round Four = 12.

Have each student choose a Mount Rainier animal they would like to be. Animals found at Mount Rainier include black bear, banana slug, cougar, gray jay, black tail deer, garter snake, elk, mosquito, marmot, dragonfly, and beaver. Write the name of their animal on a name tag and tape it to themselves.

Go outside and have the students stand in a large circle in the center of the play area. Tell them they are animals living in the park and they must search for food, water and shelter to survive.

Round 1

Randomly scatter the resource cards over the playing area and tell the students they need to gather at least one card of each color for them to survive (they are allowed to collect more than one). To ensure students walk, not run, require them to use all fours (hands and feet) when playing and do not allow any pushing.

After the students have gathered all the cards, find out who got enough cards and who did not. Those that did not pick up at least one of each resource card must "die and decompose" (let them get dramatic!) and become spectators. Explain every animal needs to find enough resources and is competing with other animals.

Round 2

Have the "decomposed" players form a large circle with the rope. The students who "survived" the first round should stand inside the circle. Scatter cards for round two in the circle and repeat the rules. Play as before. Make the point that as the size of a nature reserve decreases, the available food, water and shelter also decline, making survival more of a challenge.

Round 3

Tighten the rope circle now, making the park area smaller, barely large enough for the remaining students to stand in. (The rest can stand off to the side as spectators.) Repeat the procedure using the round three number of cards. Again, briefly point out that as the park area decreases, so does the number and variety of animals.

Round 4

Make the circle smaller, too small for the remaining students to fit. Using the round four set of cards, play the game one more time.

In your final discussion, point out that animals need wilderness habitat to survive. If there is not enough land to supply the food, water and shelter for wildlife, their numbers will decline and perhaps even disappear i.e. extirpation or extinction. As illustrated in the last round of the game, the habitat can be reduced to a point where there isn't enough space left. National parks and wilderness areas are set aside to preserve habitat and its resources. As development expands along the park boundaries, the remaining resources within the park become more valuable to wildlife.

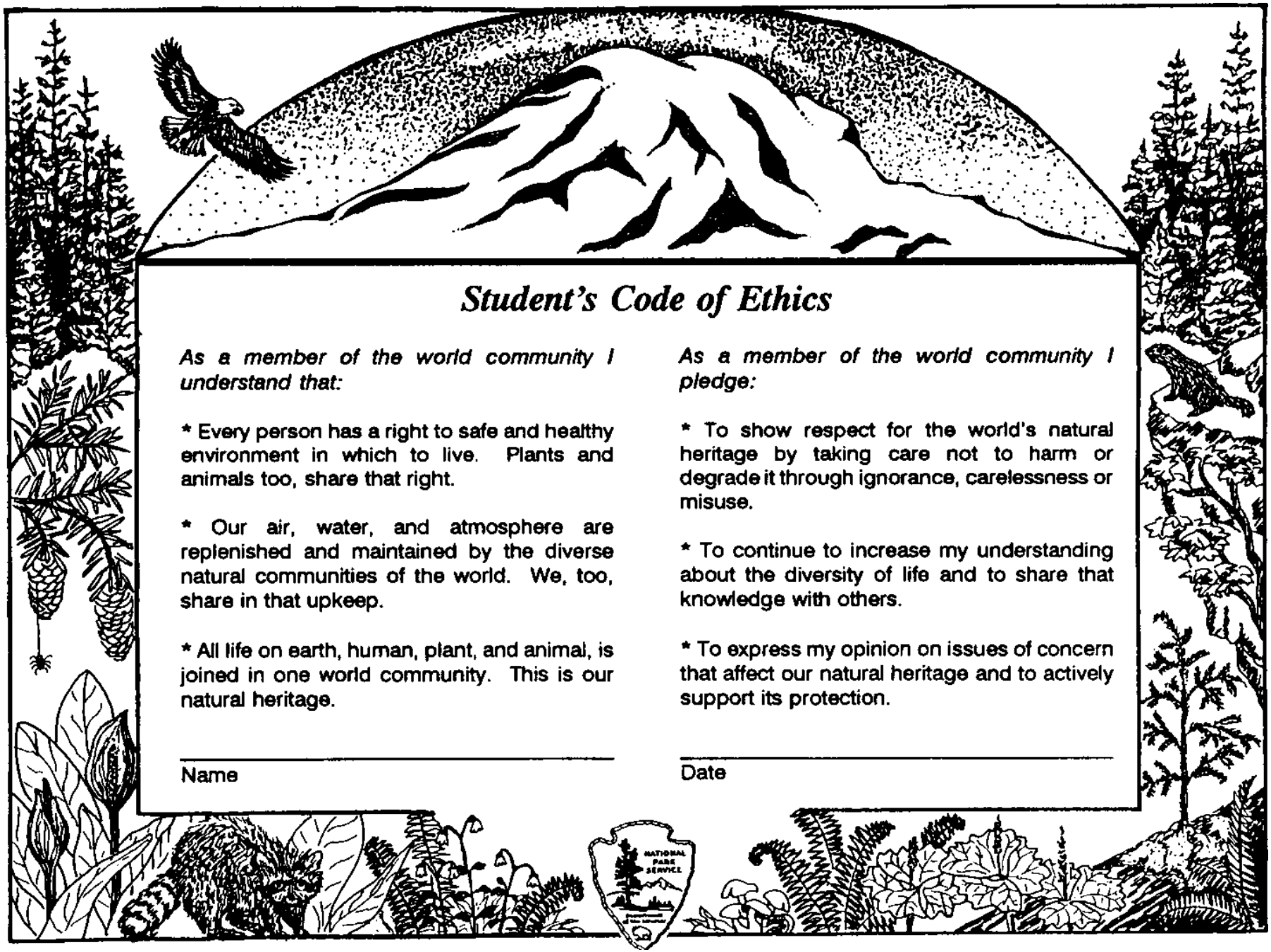
Scientists are now beginning to understand that the resources of a park may not be sufficient for plant and animals to sustain themselves. Therefore, park scientists are working with surrounding neighbors to keep wild areas outside the parks intact.

Ask the students to think of ways they can help preserve and protect wilderness areas like Mount Rainier. How can they protect natural areas in their own neighborhood? in the Nisqually River basin? Possibilities include leaving an area cleaner than you found it, being careful not to cause erosion, and writing their congressperson or other decision makers for their support in protecting our natural resources.

(from "What Happens If We Run Out?" in Olympic National Park's *The Living Forest*)

Extensions

1) Wilderness protection can sometimes come in conflict with human needs and desires, causing considerable controversy. Have students follow "Wilderness Current Events" and look for news about natural resources issues on TV, radio, in newspapers and magazines. Bring in articles to post on the bulletin board; hold a weekly discussion period about these current events.
2) Have students review the National Park Service's "Organic Act" that set the precedence for establishment of national parks (see introduction). Then ask students to write their own mandate to preserve and protect a natural area. Park brochures can be used to introduce the class to park resources. Students can design their own brochures for a particular area and display them.
3) Discuss with the class the "Student Code of Ethics" (a copy is included with this activity). Make a copy for each student and have them read the statements aloud, then sign and date their certificate.



Student's Code of Ethics

As a member of the world community I understand that:

* Every person has a right to safe and healthy environment in which to live. Plants and animals too, share that right.

* Our air, water, and atmosphere are replenished and maintained by the diverse natural communities of the world. We, too, share in that upkeep.

* All life on earth, human, plant, and animal, is joined in one world community. This is our natural heritage.

As a member of the world community I pledge:

* To show respect for the world's natural heritage by taking care not to harm or degrade it through ignorance, carelessness or misuse.

* To continue to increase my understanding about the diversity of life and to share that knowledge with others.

* To express my opinion on issues of concern that affect our natural heritage and to actively support its protection.

Name

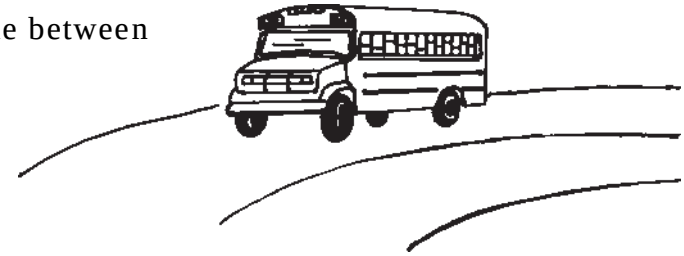
Date

On-Site Activities

"The clearest way into the Universe
is through a forest wilderness."

– John Muir

Enroute Activities



Here are activity ideas for the long bus ride between school and Mount Rainier National Park.

Nisqually River Basin Map

A Nisqually River Basin Map is included with this guide. Use it to mark your route as you go along. Also, see "On the Road to Paradise" activity.

Bus Bingo

A Bus Bingo game is included in the Student Log Book. You may want to have your students illustrate the squares.

Question Sheet

Devise a list of things for students to look for related to the watershed e.g. count the number of bridge crossings, stream tributaries, waterfalls, etc.; note different land uses.

Nisqually River Observations

Stop at several places along the way to compare and contrast the river.

Nisqually Glacier Ancestors

Point out 0.2 miles west of the town of Ashford on Highway 706 the old terminal moraine of the Nisqually Glacier of 20,000 years ago. (Purple-gray to brown loose rocks make up this moraine.)

At the town of Elbe inform students that the ice of the Nisqually Glacier's ancestor during the Pleistocene (Ice Age), 40,000 years ago, was 1,600 feet thick at this point. That's as high as a 160 story building or almost as high as three Seattle Space Needles stacked on top of each other!

At Alder Lake Dam, visible from Highway 7, point out that this was the most westerly extension of the ancestor of the Nisqually Glacier during the Pleistocene. This is about 30 miles beyond the present terminus in the park.

On The Road To Paradise

Subjects
social studies
geography
history
science

Skills
observation
compare/contrast

Materials
- *Nisqually River Basin Maps**
- Washington State road map

** provided*

Objective

Students will gain a better understanding of the geography of the Nisqually River basin, and be able to locate key features on the Nisqually River Basin Map.

Procedure

The bus trip to Mount Rainier presents a valuable opportunity for students to survey the Nisqually River basin. This descriptive "travelogue" enables teachers to serve as a guide by pointing out salient features and landmarks.

1) Inform the students while enroute to the mountain that you will be periodically pointing out geographic points of interest. Provide students with copies of the Nisqually River Basin Map so that they can follow along (master copy of map included in Resources section of this guide).
2) This activity presumes that most schools will take all or part of State Route 510 to 702 to 7 to 706, which basically parallels the river. Pick up the route wherever you can. Be observant as these points really whiz by, even in a school bus. Many of the featured points have identifying signs. The mileage figures are only approximate guidelines. If you miss a point, don't worry – another will soon be along. See if students can determine where they are on their maps as they travel up the watershed.
3) The narrative bullets for each point are brief. If possible, try to draw connections to appropriate pre-trip activities and lessons. While true discussions are all but impossible on the bus, perhaps students can share a few of their observations with the whole group.

Site Narratives

#1 **Nisqually Indian Reservation** (approx. 7 miles southeast of Lacey on SR. 510) – The Nisqually Tribe is the prime steward of the Nisqually River fishery resources. The Nisqually people have resided in the watershed for thousands of years.

#2 **Yelm** – Founded by pioneer James Longmire in 1853, Yelm most likely means "shimmering heat waves on the prairie" in the Nisqually tongue. Longmire later went on to establish Longmire Mineral Springs in what is now Mount Rainier National Park.

#3 Yelm Creek (approx. 1/2 mile past Yelm branch of Key Bank) – This creek, long degraded by livestock impacts and invasive reed canary grass, continues to undergo restoration efforts.

#4 Nisqually River at McKenna Bridge (approx. 1 mile past Yelm Creek) – Ask students to remember the river at this point so they may contrast it to the braided river they will soon see in the park.

#5 Ohop Creek (approx. 1 mile past the Ohop Grange building) – The source of this Nisqually tributary is Ohop Lake.

#6 Mashel River (approx. 2.5 miles past Ohop Creek) – This is the largest tributary to the Nisqually River. The Mashel River originates in the Elbe Hills, the foothill area just west of Mount Rainier. Several feeder streams such as Beaver Creek, Busy Wild Creek, and the Little Mashel River converge here to create this major river.

#7 University of Washington Pack Forest (approx. 1.3 miles past the Mashel River) – The Charles L. Pack Experimental Forest is operated by the University of Washington's School of Forestry. Here, students can study a variety of forest practices and ecological communities.

#8 La Grande (approx. 1/2 mile past entrance to Pack Forest) – Electricity generated from the Nisqually Hydroelectric Project is transmitted to the Tacoma area.

#9 Nisqually Hydroelectric Project (Students will need to keep their eyes peeled toward the canyon while traveling through the twists just past La Grande. Both dams, first La Grande Dam, 1 mile past La Grande, then the much larger Alder Dam, 2.5 miles past La Grande, are briefly visible) – Tacoma Public Utilities operates the Nisqually Hydroelectric Project. The La Grande power house, built in 1912, is among the oldest operating major hydroelectric facilities in the nation.

#10 Alder Lake (first visible several miles past Alder Dam) – This large reservoir was created when the Nisqually River was impounded by Alder Dam.

#11 Elbe (located at the head of Alder Lake) – This historic German logging community is now the hub for the Mount Rainier Scenic Railroad. Today, the sawmills are long gone and the importance of tourism to the local economy continues to grow. Here, the last of the free flowing Nisqually enters Alder Lake.

#12 Mainstem of the Nisqually River (visible numerous times enroute between Elbe and the park gateway) – Ask students to observe the glacial qualities of the river, e.g. braided pattern, milky coloring caused by glacial flour (finely ground suspended rock particles).

#13 Mount Rainier National Park Gateway (approx. 13 miles past Elbe) – As the bus passes under the mammoth log gateway to the national park, remind your students that they are entering a living museum. Ask them to be observant for apparent differences in the forest, such as the size of the trees, increased shade and different plant communities on the forest floor.

On-Site Activities

The On-Site section of this guide is divided into two parts: the teacher's background information with lesson plans and the Student Log Book. Make copies of the Student Log Book for each student to complete on the field trip to Mount Rainier. The log books contain the following activities:

Life Zone Profile and Checklists

As you proceed up the mountain have the students fill in the life zones on their profile sheet with the correct life zone name and drawings of the appropriate plants and animals. Life zone checklists are also included to keep track of what plants and animals are found on their field trip.

Life zone landmarks in the park between the Nisqually entrance and Paradise:

- **Lowland Forest Zone:** Entrance to Cougar Rock campground
- **Pacific Silver Fir Zone:** Cougar Rock campground to the Stevens Canyon Road junction (above Narada Falls)
- **Subalpine Zone:** Stevens Canyon Road junction to Panorama Point on the Skyline Trail, above Paradise
- **Alpine Zone:** Panorama Point to Columbia Crest, the summit of Mount Rainier

Site Specific Worksheets

Glacial River Study, Young Forest Study Plot, How Wet Are Your Woods?, Breathing Leaves, Old-Growth Forest Study Plot, Biodiversity Hunt, Ricksecker Point, Snow What?, Nisqually Vista Trail, and Jackson Visitor Center Discovery Sheet.

Journal

Blank journal pages are included for students to draw or write down personal observations, reflections, and/or poetry during the course of the trip. You may instead choose to remind students to be prepared to write a reflective follow-up of their trip experiences back in the classroom. In any case, let the natural surroundings be the teacher!

Following your field trip to Mount Rainier go over log books with the students and complete some of the activities. Refer to the Post-Trip section of this guide for additional follow-up lessons.

Don't Just Do Something, Sit There!

It's important for students to have time to just enjoy and experience the grandeur of the park and mountain without an "assignment". It is hoped the first time visitor as well as those returning many times will be personally touched and nourished by nature and be inspired to love and respect the park. As Japanese conservationist Tanaka Shozo wrote, "The care of rivers is not a question of rivers, but of the human heart."

Sample Field Trip Itinerary for Mount Rainier

Your field trip to Mount Rainier National Park can include several different stops depending on your time, the weather, and the focus of your trip. Included in this guide is a map to help you locate the various stops. We include here a sample itinerary which takes in four stops:

1) **Sunshine Point**: Glacial River and Young Forest Study
2) **Longmire**: Old-Growth Forest Study, How Wet Are Your Woods?, Breathing Leaves, Biodiversity Hunt*
3) **Ricksecker Point**: Geologic and Life Zone Overview
4) **Paradise**: Nisqually Vista Trail, Snow What?, Jackson Visitor Center Discovery Sheet

You may choose to do the Glacial River Study at the Carter Falls Trailhead, the Young Forest Study Plot at Kautz Creek, and the old-growth forest activities at the Westside Road or Longmire, but in the interest of time and logistical ease we recommend the four stop itinerary listed above. The activities will be described in only one location, so you will need to refer back to them if you wish to design your own itinerary.

Most of the activities will be completed by students in small groups. To save time, divide the class into groups of five or six before the field trip. The weather on the mountain is unpredictable and may affect your choice of activities so please be flexible during your visit. Fall (September and October) is an especially good time to visit the park, before snow covers the ground. There can still be 10 feet of snow at Paradise in early June!

Following are estimated time frames to help you in planning your trip to the park. It is suggested that a field trip to Mount Rainier extend beyond the normal school day, if possible, in order to get the most from the experience.

** NOTE: Call the park, (360) 569-2211 ext. 3313, before your trip for current recommendations regarding site location for these activities.*

Estimated Travel Times

- Nisqually Entrance to Sunshine Point (1/4 mi.) - 1 min.
- Sunshine Point to Kautz Creek (3 mi.) - 10 min.
- Kautz Creek to Twin Firs (1 mi.) - 5 min.
- Twin Firs to Longmire (2 mi.) - 5 min.

(total time from Nisqually entrance to Longmire = 20 min.)

- Longmire to Carter Falls Trailhead (2 mi.) - 5 min.
- Carter Falls to Ricksecker Point (4.5 mi.) - 12 min.
- Ricksecker Point to Paradise (5.5 mi.) - 18 min.

(total time from Longmire to Paradise = 35 min.)

Estimated Stop Times

- Sunshine Point - 15 min. if observing only; 25 min. for each activity
- Kautz Creek - 15 min. if observing only; 25 min. if doing an activity
- Twin Firs - 30 min. for forest study plot; 10-15 min. for biodiversity hunt
- Longmire - 15 min. for restrooms; 15 min. for museum; 20 min. for Trail of the Shadows; 30 min. for forest study plot
- Carter Falls Trailhead - 15 min. if observing only; 25 min. for river study
- Ricksecker Point - 15 min.
- Paradise - 15 min. for restrooms; 60 min. for Nisqually Vista trail; 30 min. for visitor center exhibits; 20 min. for audiovisual program; free time
- Lunch?????

Sample Field Trip Schedule

9:30am	Arrive at Park, stop at Sunshine Point for river and forest studies. (1 hr.)
10:45am	Stop at Longmire for restrooms and lunch (35 min.), and forest studies. (45 min.)
12:30pm	Stop at Ricksecker Point (weather permitting; 15 min.)
1:05pm	Arrive at Paradise
3:00pm	Leave Paradise
3:50pm	Leave Park

Mount Rainier Site Descriptions

Following are brief descriptions of the different study sites at Mount Rainier National Park mentioned in this guide.

Sunshine Point (Stop 1)

A quarter mile inside the southwest park boundary is Sunshine Point campground, the only campground open year-round at Mount Rainier. It also has the only covered picnic facilities in the park. Other services include chemical toilets and a water spigot. Positioned on a flat floodplain, Sunshine Point is on the banks of the Nisqually River and was destroyed by a major flood in December 1977. It was rebuilt and is now an example of the early stage in forest succession.

Westside Road/Tahoma Creek

At one time, there were plans to build a road all around Mount Rainier but the western portion was never completed. Due to recurring damage from glacial outburst floods, only the first three miles of the Westside road is now open. It is accessible by motor vehicle, generally between late May and early November. A parking lot and chemical toilet are located at the road closure. This area affords a chance to see the results of the power of natural forces. Look for evidence of Tahoma Creek's major debris flows of the late 1980's e.g. deeply cut channels, mud, boulder and log debris, and numerous standing snags. Some of the finest lowland forests in the park are also found in this area.

Kautz Creek

Notice how the road goes up hill as you come to Kautz Creek, then descends on the other side. A sudden mud and debris flow in October 1947, spilled down Kautz Creek, burying the forest and old park road under 35 feet of boulders and mud! The Kautz Mudflow was the result of unusually heavy rains that cut through part of the Kautz Glacier, causing flood surges of ice, cement-like mud, rocks and debris downvalley. The snags seen along the creek were killed as a result of their roots being buried too deep and suffocating.

The forest has steadily reclaimed the area. Here one can see forest succession in action. A large parking area, an interpretive sign, hiking trail, and picnic tables are located at Kautz Creek, halfway between the Nisqually entrance and Longmire. This is also the first view of Mount Rainier from the park road.

If you decide to do the Young Forest Study Plot at Kautz Creek you should take the class down the path by the west end of the parking lot and follow the old trail into the trees.

Twin Firs

Located four miles east of the Nisqually entrance, this trailhead has a paved pullout on the north side of the road and is marked by a wayside interpretive sign on "Low Elevation Forests". The 1/3 mile loop is not maintained at this time and is difficult to follow. It offers an excellent example of an old-growth Douglas-fir forest.

Longmire *(Stop 2)*

In 1883, returning from a summit climb, mountain guide James Longmire discovered mineral springs at the edge of a broad meadow near the Nisqually River. Mr. Longmire filed a mineral claim for the site and built a rustic summer resort which served adventurous visitors for over 30 years. Since becoming a national park, the number of visitors has increased and the facilities at Longmire have expanded. Open year-round, Longmire houses one of the National Park Service's oldest museums (with exhibits on glaciers, life zones, and the native peoples' use of the forest and river), a hiker information center (open June through September), restrooms, picnic tables, gift shop/general store, restaurant and overnight lodging.

Also at Longmire is the "Trail of Shadows", an easy 3/4 mile, self-guiding trail, that introduces you to the rich human as well as the natural history of the area. Along the trail you will find mineral springs, a beaver pond, one of the Longmire's cabins and ancient trees. Look for black-tailed deer feeding in the meadow.

The Old-Growth Forest Study Plot, Breathing Leaves, and How Wet Are Your Woods activities can be done here. Contact the park's Education Office for the best location.

Carter Falls

The Carter Falls trailhead begins 2 miles above Longmire on the road to Paradise. This trail to Carter and Madcap Falls, part of the 1895 trail to Paradise Valley, is a short, two mile round trip, easy to moderate hike. It begins with three log bridge crossings over the active Nisqually River. **Safety warning: The bridge crossings and swiftly moving water can be extremely dangerous! All students will require close supervision in this area.** Follow the old road from the river through the lowland second and old-growth forests for an excellent look at forest succession.

It is also a good area to compare an active glacial river (the Nisqually) with an inactive one (the Paradise River). When the road becomes a true trail, look for the large wooden pipeline that carried water to a powerhouse from the 1920's to 1960's. (2 mi. roundtrip; 500 ft. elevation gain)

The Glacial River Study can be done at the Carter Falls Trailhead instead of at Sunshine Point. We recommend the shoreline of the stream channel before you cross the second bridge.

Ricksecker Point *(Stop 3)*

Ricksecker Point was named for Eugene Ricksecker, the engineer who between 1903 and 1910 surveyed and oversaw the construction of the original road to Paradise. On a clear day, the Ricksecker Viewpoint offers a sweeping view of Mount Rainier and the Nisqually Glacier to the north; the U-shaped Nisqually River valley, 1,000 feet below, to the south. Moraines, old lava flows, and other geologic features are visible from this 4300 ft. vantage. The viewpoints are located on a short one way spur road.

Forgo this stop if the visibility is poor.

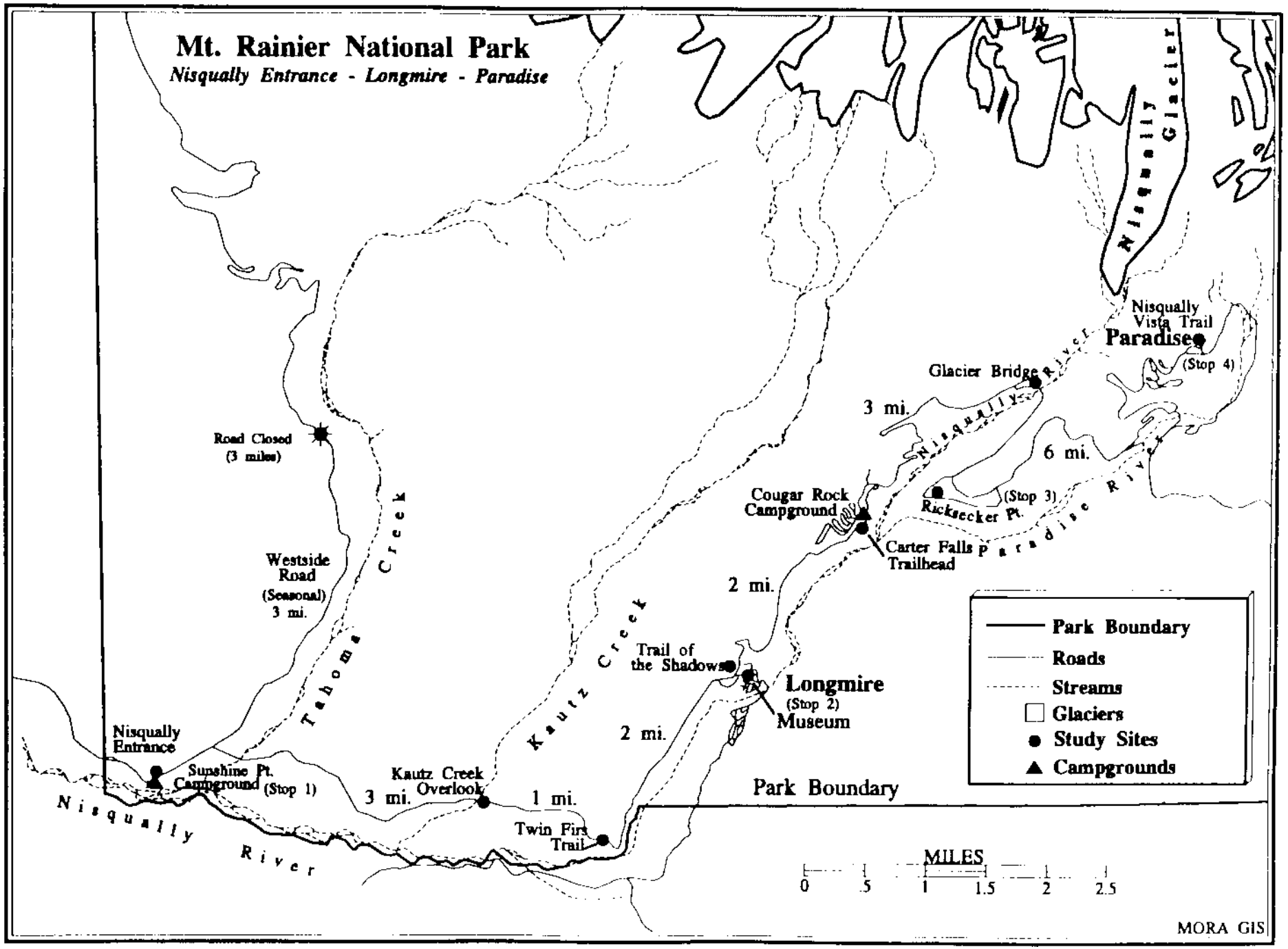
WARNING: STEEP CLIFFS!! STAY OFF AND BEHIND THE ROCK WALLS!!

Paradise *(Stop 4)*

"It looks like paradise!", exclaimed Martha Longmire in 1885 when she first saw this beautiful subalpine valley. By 1896, horse stages were bringing visitors to Paradise and in 1898, a tent city with dining facilities called "Camp of the Clouds" was established. Automobiles arrived in 1915 and the Paradise Inn opened two years later. Gradually other facilities were added. Today there is seasonal overnight lodging and climbing guide service, plus year-round food services, ranger station, restrooms, picnic area and visitor center. There is a system of hiking trails at Paradise as well, some of which are paved. If visibility is good, the Nisqually Vista Trail is highly recommended. It begins near the visitor center, winding through meadows and forests for 1 1/4 miles, gaining 200 feet in elevation. A great view of the Nisqually Glacier greets visitors on clear days.

The road to Paradise is open year-round though facilities are limited during the winter months. The Henry M. Jackson Memorial Visitor Center (information, exhibits, films, observation deck, restrooms, snack bar and gift shop) is open daily May til mid-October; weekends and holidays only the rest of the year. The restroom in the upper parking lot is open year-round. Paradise is 12 miles beyond Longmire, approximately a half hour drive without stops.

At 5400 feet, snow doesn't leave the Paradise meadows until mid-July and it can snow any month of the year. Flowers start appearing as the snow melts, with the peak of blooming around early August. Be prepared for wet, cold weather and quick changes in the temperature. Always stay on the trails to protect the fragile meadow plants.


Mt. Rainier National Park
Nisqually Entrance - Longmire - Paradise
Nisqually Glacier
Nisqually Vista Trail
Paradise
(Stop 4)
Glacier Bridge
Nisqually River
3 mi.
6 mi.
Road Closed
(3 miles)
Cougar Rock
Campground
(Stop 3)
Ricksecker Pt.
Paradise River
Carter Falls
Trailhead
Westside
Road
(Seasonal)
3 mi.
Tahoma Creek
2 mi.
Kautz Creek
Trail of
the Shadows
Longmire
(Stop 2)
Museum
Nisqually
Entrance
Sunshine Pt.
Campground
(Stop 1)
Kautz Creek
Overlook
3 mi.
1 mi.
2 mi.
Twin Firs
Trail
Park Boundary
Nisqually River
Park Boundary
Roads
Streams
Glaciers
Study Sites
Campgrounds
MILES
0
.5
1
1.5
2
2.5
MORA GIS

Glacial River Study

Subjects
science
math

Skills
describing
measuring
estimating
listening
recording

Materials
(for each group)

- jar with lid
- 25 foot length of string wound around a stick
- watch with second hand
- water testing kit, if available
- thermometer
- *Glacier River Study* worksheet*

** provided*

Note: This activity may be done at Sunshine Point (stop 1) or the Carter Falls trailhead.

Learner Outcome

Students will observe and measure the physical and chemical characteristics of a glacial river.

Background

(Refer to Pre-Trip activities)

In determining the health of a river, several factors must be taken into account such as how the water will be used e.g. for drinking, habitat, recreation, or irrigation? Each use has different minimum standards to ensure the water is safe for that use.

Many different components make up the overall water quality. Following are a couple of the most commonly tested components with a brief description of each. Other factors to consider include turbidity, nutrient level, velocity, density and surface tension.

pH

Different levels of acidity and alkalinity in water solutions are expressed in terms of pH. The pH scale ranges from 0-14. The higher the pH above 7, the more basic the substance; the lower the pH below 7, the more acidic the substance. Pure water is neutral with a pH of 7, however the pH of water depends upon the environment that it passes over since water can dissolve substances that can change its pH. The pH of water plays an important part in the distribution of plants and animals in the environment.

pH Ranges That Support Aquatic Life:

Bacteria	1.0-13.0
Plants (Algae)	6.5-13.0
Some Insects	6.0-9.0
Most Insects and Fish	6.5-7.5

(from *Investigating Your Environment*, USFS)

Temperature

Water bodies vary greatly in temperature according to latitude, altitude, time of day, season, depth of water and many other variables. The temperature determines what aquatic species may be present. It also controls spawning and regulates other activities of an organism's growth and development.

Solubility

Many substances form a solution with water, dissolving completely, while others form a suspension, and will settle out if undisturbed. Various gases, including oxygen, are soluble in water as well. Because all living things depend on oxygen in one form or another, dissolved oxygen (DO) is of great significance in aquatic environments. Fast, cascading streams are rich in oxygen and the cooler the water, the more DO it will hold.

Procedure

This activity may be done here at Sunshine Point or at the Carter Falls Trailhead (near Cougar Rock Campground). Have each group work in a different **safe** place along the stream. If you follow the paved trail along the river to the west from the Sunshine Point Picnic Area parking lot, you will come to a small beach where this activity may be conducted. If you plan to do the forest succession activity after the river study, you may wish to go to the river at the east end of Sunshine Point, which is the best location for the young forest study plot. This site is not as safe as the area west of the parking lot for the Glacier River Study because of unstable and steep banks.

Distribute study materials to each group of students, assign each group to an area along the river, and have them complete the Glacial River Study log book page. Have students test the water velocity at different parts of the river, i.e. farther out, closer to shore.

Young Forest Study Plot

Subjects
science
math

Skills
mapping
measuring
observing
estimating
describing
classification
spatial understanding
identification

Materials
(for each group)

- 60 foot length of string, marked at 15 foot intervals and wound around a stick
- thermometer
- *Forest Study Plot* worksheet*

** provided*

Vocabulary
succession
ecosystem
climax forest
pioneer species

Note: This activity may be done at Sunshine Point (stop 1) or Kautz Creek.

Learner Outcome

Students will record the characteristics of a young, early succession forest, and make comparisons to an old-growth forest.

Background

Succession is a change over time in the species and structure of an ecosystem such as a forest. It occurs when a species establishes itself on newly available terrain and is, in turn, succeeded by other species until the species composition remains fairly constant, resulting in what is called a climax community. It takes 750-1,000 years for a forest in the Pacific Northwest to become a climax forest.

Forest succession is difficult to study due to the fact that major tree species can live for more than a millennium, much longer than any researcher or research grant. Yet, succession is integral to every aspect of forestry – hydrology, timber, wildlife and fisheries management, recreation. Understanding succession is key to forest management.

Succession usually begins when some kind of disturbance occurs e.g. fire, landslide, windstorm, or logging. The first species to colonize an area are known as pioneer species. Pioneer species are opportunistic, taking advantage of the sunnier, breezier, more open conditions. They generally grow up and outward quickly. Common colonizers are grasses, herbs, shrubs and tree seedlings such as red alders. Some species like the western hemlock can be either a pioneer or a climax species under different circumstances. Douglas-firs also colonize disturbed sites, competing for water, nutrients and light. If they reach the canopy, Douglas-firs can outgrow, shade and outlive their competitors.

Succession involves not only trees, but other plants, fungi and animals which may do better in certain successional stages. The changing species and structure of a community can alter its physical conditions as well. A closing forest canopy will allow less sunlight to reach the ground, weaken wind speed, and result in the soil retaining more moisture.

Procedure

1) Follow the path along the river to the east from the Sunshine Point Picnic Area parking lot. You will notice an open forest area of alders, cottonwoods, Douglas-firs, willows, and grand firs. This is a forest in the early stage of succession and is an excellent location for the students to conduct their plot studies.
2) Distribute 60 foot lengths of string and assign each group of students to an area to set up their 15' x 15' square plot. Have them mark off their plots with the string. It may help to have one student stand at each of the four corners and hold the string until it is positioned. Sticks may then be used to hold the string in place.
3) Students will be mapping their plot on a simple 3 x 3 grid with nine squares total. Explain to the students that they will need to estimate the approximate location of the various components in their plots and have them use the key shown on their grid sheet to represent these components. If something is located in the plot which is not included in the key the students may create their own symbol for it.
4) Have student groups complete the Young Forest Study Plot log book pages.

Breathing Leaves/ How Wet Are Your Woods?

Subjects
science
math

Skills
observing
reasoning
measuring

Materials

Breathing Leaves

• one plastic bag and an 18 inch piece of string per group

• worksheet*

How Wet Are Your Woods?

• one jar for each group

• one measuring cup and a set of measuring spoons for the whole class

• worksheet

** provided*

Vocabulary
transpiration

Note: These activities may be done at Twin Firs (stop 2) or Longmire.

Learner Outcome

If it is a sunny day, students can learn about leaf transpiration with the activity, "Breathing Leaves."

If it is raining, use "How Wet Are Your Woods?" to measure and compare the amount of rain that falls on the forest floor under different conditions.

Procedure

These activities both take thirty to sixty minutes, so they should be set up as soon as you arrive at the site. Have the students follow the instructions in their log books. Assign each group an area to complete one of these activities, along with the Old-Growth Forest Study Plot.

Warn students to be careful where they walk. There are many devil's club plants which have sharp spines, and many rotting logs and other debris on the ground which makes walking off the trail hazardous.

Old-Growth Forest Study Plot

Subjects
science
math

Skills
mapping
measuring
observing
estimating
describing
classification
spatial understanding
identification

Materials
(for each group)
• 60 ft. length of string, marked at 15 ft. intervals and wound around a stick
• thermometer
• worksheet
** provided*

Vocabulary
succession

Note: Contact the park's Education Office, (206) 569-2211 ext. 3313, for a suitable location for this activity. In order to minimize potentially high impacts, we must be selective in the areas used.

Learner Outcome

Students will record the characteristics of an old-growth forest and compare them to an early succession forest.

Background

(Refer to Young Forest Study Plot.)

Like most early colonizers, Douglas-firs are not very shade tolerant and their seedlings don't grow well beneath a full canopy. At lower elevations throughout most of western Washington, the most common tree seedling under old-growth Douglas-firs is the western hemlock. Their seedlings can tolerate low light levels until the trees shading them die. When a big tree dies, a gap in the canopy opens up, letting more light reach the understory and the hemlock's growth accelerates. The hemlock's ability to "hang on" in the shade allows them to sooner or later replace the Douglas-firs. Thus shade tolerant species eventually become the canopy trees. Western red cedars can also establish themselves in the shade and can live over a thousand years, but except in spots collecting standing water, they are usually interspersed with other trees.

The uneven lighting in an old-growth forest leads to a more complex vertical structure than a young forest. Sunny patches are occupied by herbs and shrubs whereas shady spots have more understory trees. The natural landscape is not a uniform community. Instead it is more like a quilt or mosaic.

General Pattern of Old-Growth Douglas-Fir Forest Succession in the Pacific Northwest

10 yrs.	Alder and Douglas-fir saplings establish claims
50 yrs.	Alders slow down in deepening shade of the Douglas-firs
120 yrs.	Dense Douglas-fir canopy
250 yrs.	Large Douglas-firs; nurse logs with hemlock seedlings
500 yrs.	Western hemlocks and red cedars; smaller understory trees; many downed logs and broken-topped Douglas-firs
1200 yrs.	Hemlocks and red cedars prevail

Procedure

1) LEAVE NO TRACE! Be sure to remind students that with so many classes using the same areas they need to be extra careful to protect the resource they came to study. Keep the impact on this special natural area to a minimum by watching where they walk and by not collecting or damaging any of the living and non-living parts of the forest. When they leave their study area it should look the same or better (e.g. pick up any litter) than when they arrived. Also, for their own safety, warn students there may be devil's club plants, which have sharp spines, and rotting logs and other debris on the ground which make walking off the trail hazardous.
2) Distribute 60 foot lengths of string and assign each group of students to an area to set up their 15' x 15' square plot. (Try to select plots that have trees.) Have them mark off their plots with the string. It may help to have one student stand at each of the four corners and hold the string until it is positioned. Sticks may then be used to hold the string in place.
3) Students will be mapping their plot on a simple 3 x 3 grid with nine squares total. Explain to the students that they will need to estimate the approximate location of the various components in their plots and have them use the key shown on their grid sheet to represent these components. If something is located in the plot which is not included in the key the students may create their own symbol for it.
4) Have student groups complete the Old-Growth Forest Study Plot log book pages.

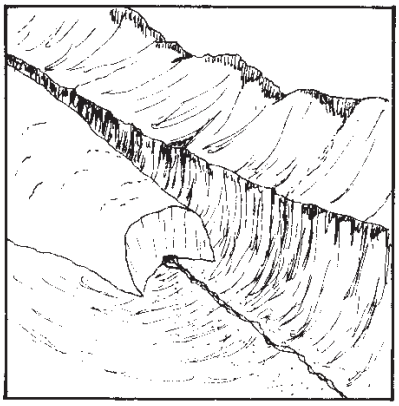
Paradise Activities

Background on Nisqually Glacier

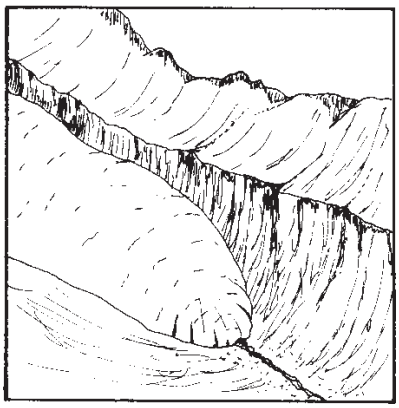
The Nisqually and its tributary, the Wilson Glacier, are a single glacier system covering 2.2 square miles. The Nisqually Glacier is the seventh largest glacier on the mountain. It covers 1.8 square miles. It is a thin glacier, generally less than 300 feet. Its thickest ice is 436 feet on the western edge, .8 mile up the glacier from its terminus. The Nisqually, which is a typical small, steep valley glacier, begins as an accumulation of ice and snow at the edge of the summit crater. This is its area of accumulation.

The Nisqually Glacier flows fastest when the glacier is full of melt water in the months of May and June. The fastest point is at its steep ice fall and its fastest speed is two feet a day. In May 1970, it moved 28 inches in a day! November to December it flows the slowest, half the rate of May-June.

The oldest ice on the Nisqually Glacier is at the snout and is 200 years old. By looking at the snout of a glacier we can tell what the glacier is doing. A retreating glacier's snout is concave or hollowed out, just as if you were to consume fewer calories than expend, your stomach would shrink and become concave. An advancing glacier's snout is convex or bulbous, just as if you were to consume more calories than expend, your stomach would grow and take on a bulging convex shape. If a glacier is standing still, neither advancing nor retreating, the snout appears wedge shaped.



Concave



Convex

Two important glacial features that the students will be observing from the Nisqually Vista viewpoint at Paradise are moraines and crevasses. Moraines are prominent features of glaciers. The material composing the moraines is derived partly from rock falls and avalanches from the valley side and partly from erosion of the valley side by the glacier and from rocks rolling off the terminus (especially an advancing one). Moraines can be lateral or terminal or medial. A medial moraine forms at the junction of a tributary glacier with the main glacier. An example is where the Wilson Glacier joins the Nisqually Glacier. The lateral moraines on one side of each valley merge and become a medial moraine some distance out on the glacier itself. Sometimes moraines create dams which form lakes after the glacier retreats. An example of this in Mount Rainier is Mystic Lake (formed by a moraine of the Carbon Glacier).

When the glacier flows over an irregularity in the valley floor or over an abruptly steepened slope, the brittle ice surface may become severely fractured producing deep crevasses. Crevasses cannot be more than about half the depth of the glacier because ice pressure closes up the open spaces. On the Nisqually Glacier, the deepest crevasse is less than 200 feet deep.

Activities

1) Analyze the snow if there is any on the ground. Complete the Snow What? log book page.
2) Have the students complete their life zone picture for the subalpine and alpine zones.
3) Walk the Nisqually Vista Trail, a 1.2 mile loop. Before you begin, discuss the importance of staying on the trail and protecting the fragile subalpine plants. Complete the Nisqually Vista Trail log book pages.
4) Visit the Jackson Memorial Visitor Center and attend a ranger map talk on the Nisqually Glacier and river. (Request this in advance of your trip by calling the park: (206) 569-2211 ext. 2328 or 3311.) Have the students complete the Visitor Center Discovery Sheet. Watch one of the audiovisual programs if available.
5) Do a silent solo sit along one of the trails (Be sure to sit on the trail or a bench, NOT in the meadows). Have students use their sense of sight, hearing, smell and touch to experience their surroundings. Soak up the scenery!

Answers to Nisqually Vista Trail Questions

Bridge

1) Snow
2) Nisqually River
3) Snowmelt, because it is clear

Weather Station

4) So it stays above the snow
5) About 12-14 feet
6) 640 inches
7) Accumulated snow turns into glaciers
8) Temperature

Fork in Trail

9) Answers will vary

Third Viewpoint

10) It's covered with rock
11) Most of it has fallen onto the ice from the surrounding cliff walls
12) Answers will vary
13) Retreating
14) Water; meltwater from the glacier

15) Label picture
16) Poem
17) Life zone

Return Loop

18) Snow, wind and ice particles in the wind
19) There are different types of trees and other plants, the trees are more sparse and smaller, and the shrubs are lower to the ground.

Answers to Jackson Visitors Center Discovery Sheet

Main Floor

1) No answer
2) National Park Arrowhead (mountain, buffalo, giant Sequoia)
3) 5400 feet
4) 1122 inches or 93 1/2 feet

Exhibit Room #1

1) Slowly; by weight and gravity
2) Provide a water supply for farms, industry and hydroelectric energy
3) Osceola Mudflow
4) Fire (volcano); water and ice (rivers and glaciers)
5) Crampons, ice ax, rope, glacier glasses
6) Answers will vary
7) Camped, built structures, walked wherever they wanted, horses
8) Short growing season, slow growth rate of plants, low temperatures
9) Stay on the maintained trails!

Exhibit Room #2

1) Answers will vary. Examples: Pika makes hay stacks. Marmot hibernates. Mountain goat has special hooves and warm, white fur.

Observation Level

1) Answers will vary
2) Yes and/or no
3) John Muir
4) 10,000 feet
5) Answers will vary

Slide Program

1) Answers will vary
2) Answers will vary
3) Answers will vary

Post-Trip Activities

Log Book Follow-Up

Glacial River Study

We measure stream flow for many reasons, such as determining if there is enough water for people to use downstream, if there is too much water and the river is going to flood.

Have students complete the Water Supply and Demand worksheet to tie in with their Glacial River Study.

How Wet Are Your Woods?

1) Have a student from each group describe their site. Discuss with the class where they would expect to find the least amount of rainfall, the most, and why. Record the students' predictions on the blackboard. Then have one student from each group write their actual amounts (from question 2 on log book page) on the board.
2) Ask the class if the results are as everyone expected, or if there are surprises. What may have caused the surprising results?
3) Ask the following questions:
   - What do the results mean for the forest?
   - Why is there such a difference between the amount of rain that was collected in an open spot and the amount that was collected next to a tree trunk?
   - If less rain falls next to a tree's trunk, how does the tree get the water it needs?
   - What happened to the "missing" water? (*Much of the rain that falls in the forest is deflected by branches and leaves, finally running down the trunk to the ground. This also helps support the wide array of lichens, mosses and other plants that grow on trees in the forest.)*
   - Where would animals be most likely to seek shelter?
   - What would this forest be like if western Washington did not receive so much rain?

Breathing Leaves

Complete number 6 on the "Breathing Leaves" page in the Student Log Book by doing the following calculations as a whole class:

1) Let's say that one Douglas-fir tree has an average of 60 million leaves and transpires approximately 16,000 gallons of water on a sunny day. Multiply the total gallons of water for one tree by the approximate number of trees in an acre of old-growth forest (10-20 in a mature stand with a closed canopy; this number varies with the age and condition of the tree stand).
2) Mount Rainier has approximately 91,000 acres of old-growth forest. Multiply the total gallons of water per acre by 91,000.

   As you can see, this really adds up to a lot of water! Old-growth forests are like great big reservoirs!! The water content of an old-growth forest canopy is 264,000 gallons per acre! And we haven't even counted the shrubs and smaller plants yet!
3) How does all this moisture affect the old-growth forest and all the living things in the watershed?

The Rest of the Story!

Go over the other pages in the Student Log Book to make comparisons and draw conclusions from the data collected on the field trip.

Water Suppy and Demand

Using the data in your Log Book from your Glacial River Study, complete the following calculations to determine the amount of water flowing in the Nisqually River at Mount Rainier.

1) Divide the distance (25 feet) the stick traveled by the number of seconds it took the stick to travel that distance to calculate the stream velocity.

   25 / _____ = _____ feet per second
   number of seconds *stream velocity*

2) Next calculate the cubic feet of water (volume) which flows per second by multiplying the width by depth by number of feet per second (see number 5 on Glacial River Study page for width and depth).

   ____ x ____ x _____ = _____ cu. ft. per second
   depth *width* *feet per second* *volume*

3) To convert it to gallons of water per second multiply cubic feet per second by 7.48 gallons (1 cubic foot of water = 7.48 gallons).

   _____ x 7.48 = _____ gal. of water per second
   cu. ft. per sec.

4) Now convert this quantity to minutes by multiplying by 60.

   _____ x 60 = _____ gal. of water per minute
   gal. per second

5) Convert this to gallons per day by multiplying the amount by 1440 (the number of minutes in a day).

   _____ x 1440 = _____ gal. per day
   gal. per minute

6) If one person uses 200 gallons in a day, divide the total water volume by 200 to see how many people this water supply can support.

_____ / 200 = _____ people
gal. per day

7) Using the Water Information Sheet, keep a log of all the water you use in a 24 hour period. Record your total usage here:

_____

Did you use more of less than 200 gallons? _____ How could you reduce the amount of water you use?

_____

_____

WATER INFORMATION SHEET

(all values are approximate)

6-12 ounces	glass of drinking water
3-5 gallons	flushing the toilet
4 gallons	brushing your teeth and letting the water run for one minute
4 gallons/min	shower
4 gallons/min	washing your hands
2 gallons	cooking a meal
8 gallons	cleaning a house
3 gallons	washing dishes for one meal
20 gallons	one load, automatic dishwasher
20 gallons	washing a car for 5 minutes
20-30 gallons	one wash load of clothes
30-40 gallons	watering a lawn
30-40 gallons	taking a bath

Source: *Denver Water Department,*
Colorado River Water Conservation District

Other Follow-Up Activities

Individual and Group Sharing

1) Write a report on some aspect of the Nisqually watershed within Mount Rainier (e.g. water quality, old-growth forests, glaciers, history).
2) Give presentations on Mount Rainier for other classes: Use slides, videos, drawings, reports, photos, skits, zap shots (requires a special camera that can put still photos on a disk which can then be shown on a television; many school districts have the equipment available), etc.
3) Create activities or games based on things the students learned on their field trip to Mount Rainier.
4) Design experiments based on something each student learned while visiting Mount Rainier. Present the experiments to the class and design exhibits on the experiments stating the hypothesis, explaining the method of research, and describing the conclusion.

Simulation Game / Class Debate

Have the class hold a town meeting or debate on an issue affecting the Nisqually River and/or Mount Rainier National Park. Divide the students into teams representing different viewpoints. Several of the curriculum materials listed in the bibliography include excellent examples of simulation games / class debates. See the activities, "Forest Full of Views" and "Let's Make a New Deal" in *Forests of Washington*, and "My Use or Your Use or Our Use" and "Vacation Homes" in *Project Learning Tree Activity Guide K-6*.

Life Zone Mural

Have students work as individuals or in groups to complete a large life zone mural for the classroom/school. Label each zone.

Creative Writing

1) Write a story of the old-growth forest from a resident tree's point of view and/ or write a story of the old-growth forest from a Nisqually Indian's point of view. Illustrate the stories.
2) Have students read the poems they wrote at Mount Rainier onto a tape, then put together a slide show or photo album on the field trip with the poetry narrating the show/album. (If the students did not write poems on the field trip they may want to do so as a follow-up back in the classroom.)

Sharing the Joy of Song

Subjects
music
language arts

Skills
singing
discussion
sharing
artistic interpretation
creative writing

Materials
- music, songs and poems about nature/environment*
- musical instruments
- paper and pencil

** some provided*

Learner Outcome

Students will discuss thoughts and feelings about the environment in music and express their personal ideas and feelings by creating their own songs/poems.

Background

Art reflects the artist. It may also influence the one who sees, hears, or feels the work of art. Social attitudes toward environmental issues are affected by the communications media, including the classical and popular arts.

Historical and contemporary artists have expressed their views about issues, including environmental ones, and have influenced others in the process. Nineteenth century naturalists like Henry David Thoreau and John Muir influenced their generation through their teachings and writings and their influence continues today. Modern day songwriters and musicians express their viewpoints and feelings through the music they write and perform.

Procedure

Describe the ways in which music and other art forms influence peoples' attitudes toward the environment. Share examples of nature/environmental music with the class (some are included in this activity or you may want to share your personal favorites). Look for ones with positive, hopeful messages as well as those with a "call to action". Discuss the lyrics and/or style.

After spending time learning about Mount Rainier and the Nisqually River basin and, if possible, taking a trip to the park, have the students think about what they have experienced and how they feel about these areas. Then instruct the students to write down their ideas and feelings (if they kept a trip journal they may want to refer to it). Using these thoughts and feelings, have the children make up their own songs or verses. They could be about a specific place, animal, experience, or issue. Use an existing tune and put new words to it or make up a new tune. Videotape and share the songs with others.

Extension

Use the written works of writers like Muir, Thoreau, Aldo Leopold, and Sigurd Olson to encourage students to write personal stories or poetry about the Nisqually River or Mount Rainier. Illustrate with their own drawings or artwork.

MUIR POWER TO YOU

by Bill Oliver

Long is the legend of the life of John Muir,
and many are the dangers he braved.
Without his leadership you can be sure,
Yosemite would never been saved.
A century later the battles remain,
the momentum we're facing is huge.
But so is the movement inspired by his name,
may his courage and his work live in you.

Muir Power to You, may the strength of a redwood be yours
Muir Power to You, with the grip of a glacier endure
Muir Power to You, John Muir would've been proud

He traveled alone on thousand mile hikes
when the weather was warm or would freeze.
He loved the Sierra when it filled up with storm
and he was tied atop a swaying tree.
He worshipped the beauty of all he could see,
Even when he was robbed of his sight.
When his vision returned he would go on to be
the protector of the range of light.

Muir Power to You, may you look with the light from within
Muir Power to You, may the wilderness become your friend
Muir Power to You, John Muir would've been proud

Scientists and teachers would arrive at the points
that his articles and lectures would claim.
Even politicians would join
with what photographers and artists would frame
When we think of John Muir it's so easy to see
the difference one person can make.
The same river's flowing through you and me,
it's living in the steps we take.

Muir Power to You, as you fight to keep that river alive
Muir Power to You, as you help another species survive
Muir Power to You, on the oceans and mountains and trails
Muir Power to You, in the classrooms and courtrooms prevail
Muir Power to You, with the grip of a glacier endure
Muir Power to You, John Muir would've been proud

(from *Audubon Adventures Songbook* with songwriter's permission; available through the National Audubon Society, Education Department, Route 4, Sharon, CT 06069)

THE NISQUALLY

To the tune of "On Top of Old Smoky"

There once was a glacier, on top of Rainier
It was very active, grinding "flour" all year.
The glacier's Nisqually, the river, the same
From top of the mountain to Puget Sound bay.

From the glacier the river, flows into the sea
Take care of the river – for salmon, for me.
This finishes my song, but rivers still run
Take care of Nisqually, which we depend on.

(in C) F C / G7 C

– lyrics by Carol Nelson

GLACIERS OF RAINIER

To the tune of "Kookaburra"

1) Mount Rainier stands in the grand Cascades
   Many are the glaciers she displays
   Kautz, South Tahoma, Carbon and Nisqually
   Twenty-one more with names.

2) A glacier forms where snow does lay
   Snow builds up and won't melt away
   High altitudes, cool temperatures
   Snow and ice will stay.

3) Glaciers are more than snow and ice
   They erode rock, shaping mountainsides
   Busy braided waters bring down glacial flour
   Active they must be.

4) Glaciers are many on Mount Rainier
   They are fascinating all through the year
   Go and discover – glaciers more than cover
   A mountain so dear.

– lyrics by Carol Nelson

Nature Channels Song

by J. Donald Walters

Flowers

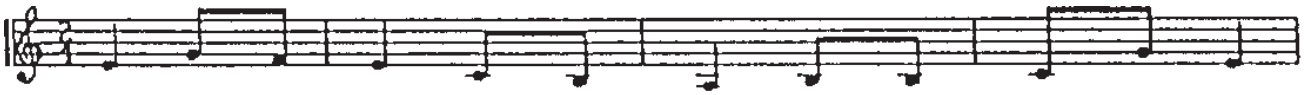
Flow-ers so soft and fra - gile stay fra - grant tho pressed to the ___ ground.

Mo ___ ther we thank You, Your joy _____ shines in ev'ry _____ thing!

May we thus learn for - bear - ance for in kind - ness love is found.

O __ pen these chan - nels that the world once more may sing.

Trees



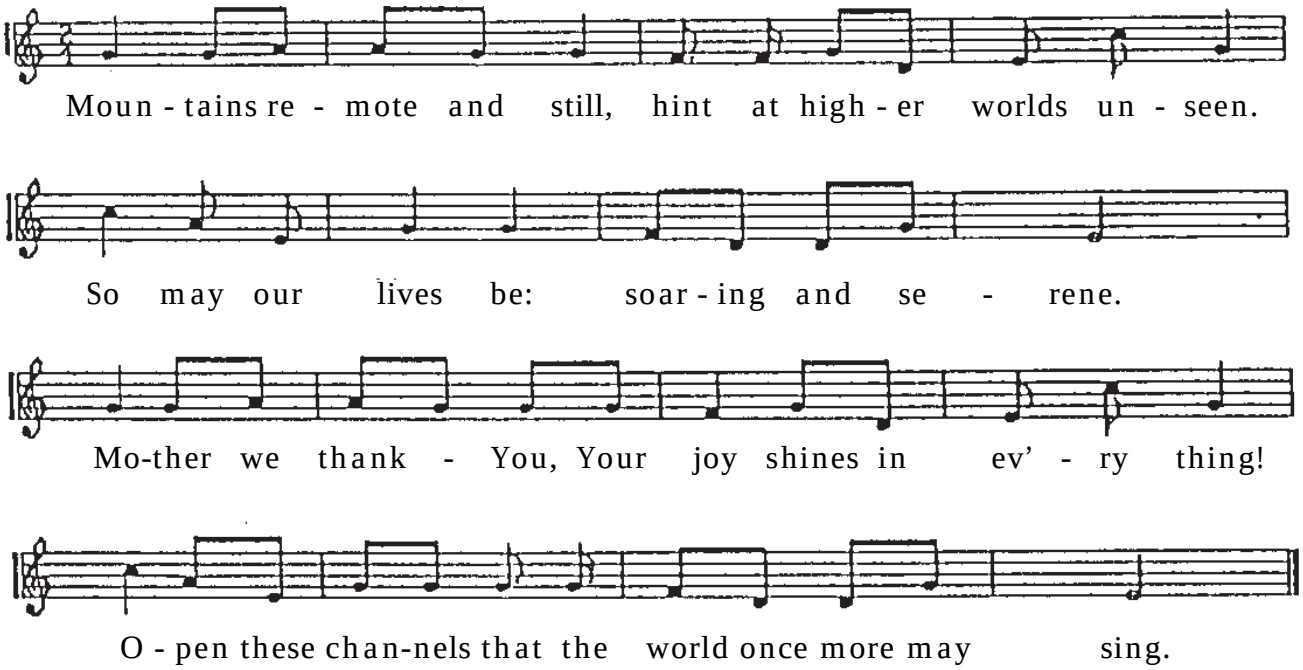
Trees, stan - ding firm, hold the se - cret of in - ner power.

Give us when test - ed, strength to en - dure.

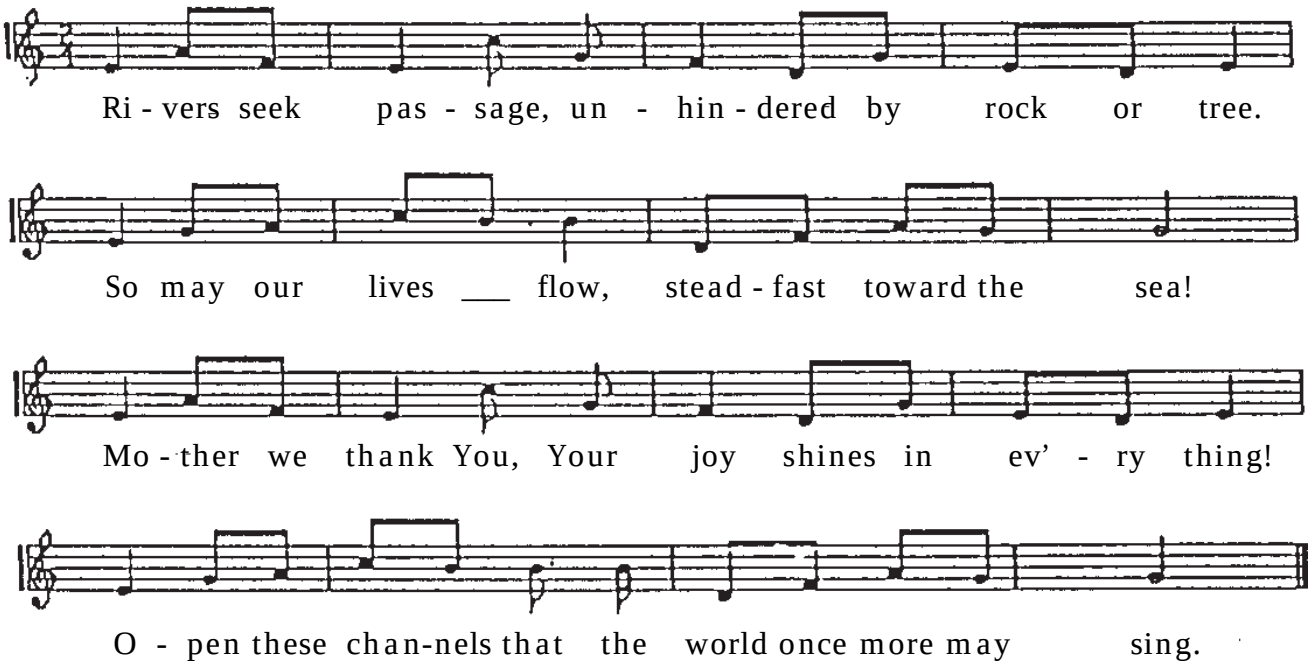
Mo - ther we thank You, Your joy shines in ev' - ry thing!

O - pen these chan-nels that the world once more may sing.

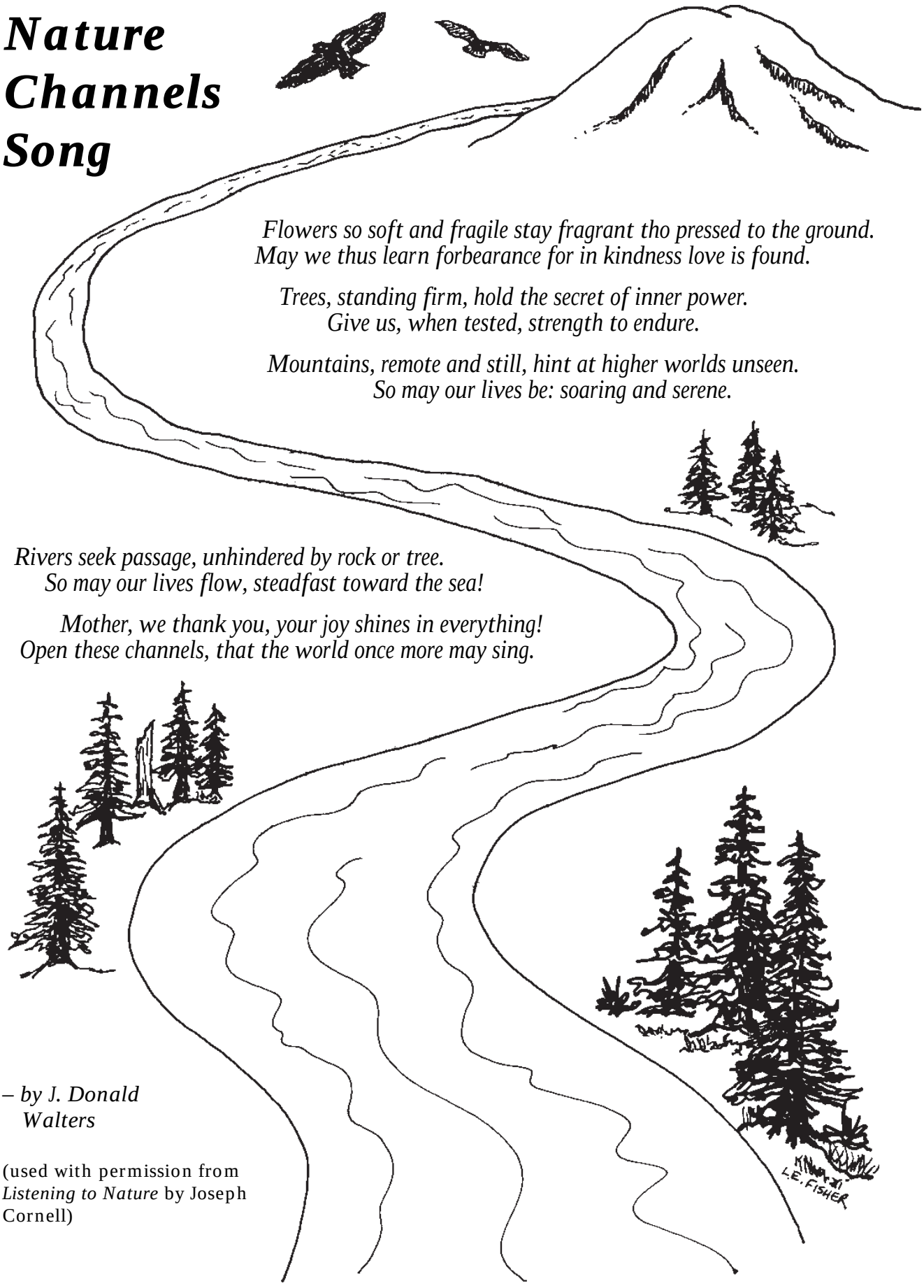
Mountains



Rivers



Nature Channels Song



Flowers so soft and fragile stay fragrant tho pressed to the ground.
May we thus learn forbearance for in kindness love is found.

Trees, standing firm, hold the secret of inner power.
Give us, when tested, strength to endure.

Mountains, remote and still, hint at higher worlds unseen.
So may our lives be: soaring and serene.

Rivers seek passage, unhindered by rock or tree.
So may our lives flow, steadfast toward the sea!

Mother, we thank you, your joy shines in everything!
Open these channels, that the world once more may sing.

– by J. Donald Walters

(used with permission from *Listening to Nature* by Joseph Cornell)

IN THE BEGINNING

We, the Giant Trees, are old,
Older than any living thing
On Earth
Long, long before the Cave Man
Chipped his stone club
In the Darkness of his cave,
Long, long before then,
Our Fathers came.

They lived in the beginning,
When the world was warm
When great beasts, long since forgotten,
Dinosaurs, mammoths, armored lizards,
Crept, ate, fought and died.

Then the Ice Ages came upon the earth.
Glaciers crept down from the Pole.
Burying all life under their piercing cold.

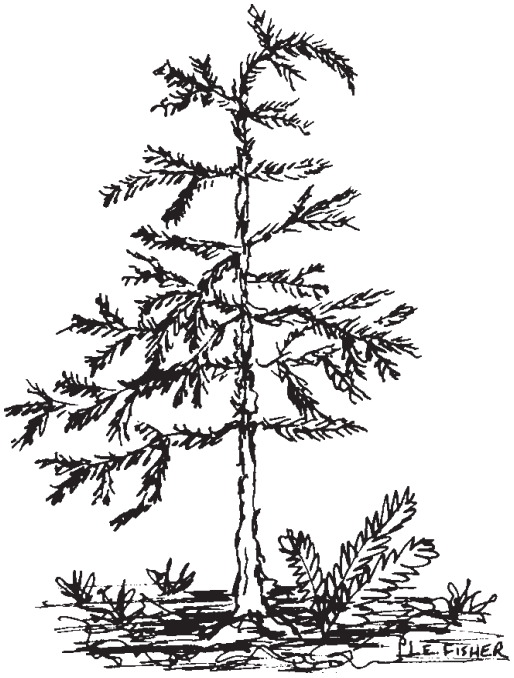
After the lingering Ice Ages were over,
And the glaciers melted,
And the world was warm once more,
Millions of trees were dead,
Frozen by the ice
Killed by the cold.

But in the southlands
of the New World
Where the glaciers never came
A few giant trees still lived
To fight alone,
All that remained of a forgotten world
All that endured from a bygone age.

I came from them.
A seed,
A seedling,
A sapling,
A youth,
A tree,
A GIANT!

From an ancient clan,
From a forgotten time,
From the morning of the world.

– Author unknown



Web of Life Game

Subjects
science

Skills
cooperative action
discussion
synthesis
reasoning

Materials
- ball of yarn or heavy string
- cards or paper
- marker

Learner Outcome

Students will gain an understanding of some of the connections among living and non-living things in the Nisqually River watershed.

Procedure

Have the group form a large circle. Start by having one person represent the sun, the source of energy of all living things. While holding on to the end of the string, pass the ball of string to whoever in the circle can think of something, living or non-living, found within the Nisqually River watershed at Mount Rainier National Park (e.g. water, Douglas-fir tree, glaciers, black bear, mosquitoes, layers of ash and pumice) that needs or depends upon the sun. This person holds onto the string while passing the ball onto someone else who names something that needs or is needed by the previous person. Continue unwinding the string until everyone in the circle is connected, creating a giant "web" (be sure to keep the string taunt but not tight enough to snap).

Conservationist John Muir once said, "When we try to pick out anything by itself, we find it hitched to everything else in the universe." Demonstrate the "ripple" effect in nature by having one student gently tug their string and then whoever feels the pull, to tug back. Eventually everyone should feel a small tug. Give an example of how this works in the real world. If an old-growth forest is logged or burned, does this mean that all the plants and animals living in the forest will die? (No, some will adapt; others will move elsewhere.) How have humans affected the Web of Life?

Variation

Have students pick something in the watershed to represent. Write the object on a card and have each student hold their card in front of them. Then pass the ball of yarn around the circle as described above (this works best if the group is sitting down), having the students decide what is connected to what and why. Finish the activity with giving the string a tug, etc.

Graphing the Drainage

Subjects
science
math
geography
(extension)

Skills
graphing
questioning
interpreting data

Materials
- graph paper
- *Graphing the Drainage* worksheet*

** provided*

Learner Outcome

Students will graph the area and volume of the Nisqually River drainage basin in Mount Rainier National Park and write three questions based on the data.

Procedure

1) Using the information on the worksheet, students will prepare two bar graphs, one on the areas and the other on the volumes of the glaciers and snowpatches of the Nisqually River basin on Mount Rainier.
2) After completing the graphs each student will write three questions based on data presented in the graph. Share questions either in small groups (i.e. one group can answer another group's questions) or as a whole class.

Extensions

1) Determine the equivalent volumes in more familiar terms e.g. how many King Domes would fit in the glaciers of Rainier?
2) Study a topo map to determine the area of the Nisqually watershed included within the boundaries of Mount Rainier National Park.

GRAPHING the DRAINAGE

1) Using information from the following table, prepare two bar graphs – one on the areas and the other on the volumes of the following glaciers and snowpatches of the Nisqually River basin on Mount Rainier.

Table of Area and Volume of Glaciers and Snowpatches of the Nisqually River Basin on Mount Rainier

Glacier or Snow Patch*	Area in Sq. Km. (Sq. Miles)	Volume in Billions of Cu. Meters (Cu. Ft.)
Snow Patch	.78 (.3)	.009 (.3)
Muir Snowfield	1.04 (.4)	.021 (.7)
Nisqually	4.68 (1.8)	.234 (7.8)
Wilson	1.30 (.5)	.057 (1.9)
Kautz	1.04 (.4)	.039 (1.3)
Success	.78 (.3)	.015 (.5)
Van Trump	.52 (.2)	.015 (.5)
Pyramid	.52 (.2)	.012 (.4)
South Tahoma	2.86 (1.1)	.138 (4.6)
Tahoma	3.12 (1.2)	.129 (4.3)

** A snow patch is an area of snow, not part of a glacier, that remains from year to year.*

2) After completing the graphs, write three questions based on data presented in the graph.

Nisqually Watershed: Past and Present

Subjects
social studies
language arts

Skills
research
communication
compare/contrast
reporting

Materials
• reference books/ articles (see Bibliography)

Learner Outcome

Students will be able to compare uses of the Nisqually River watershed during three different time periods: early native people, immigrant pioneers, and the National Park Service.

Procedure

Divide the class into three research teams, one for each of the three time periods. Have each team prepare a presentation about human uses of the Nisqually watershed for the time period assigned. Some questions to consider:

- Did humans in your time period live in the watershed? If so, in what part of the watershed did they live?
- What forest products did they use? What other natural resources? How were they used?
- Did the river, glacier, forest or other component of the watershed play a part in their religion? Their day-to-day decisions?
- Were watershed resources wasted or exploited? Which, if any, conservation methods were practiced?
- How did events in other parts of, or outside the watershed influence what happened in this area?

Compare and contrast the three time periods in relation to the Nisqually watershed. What lessons can we learn from each period?

(adapted from "The Influence of Forests in Your Region's History" in *Project Learning Tree, Activity Guide 7-12*)

Glossary

ablation The process by which ice and snow are lost from a glacier by melting, sublimation, or calving.

ablation area The lower area on the glacier where ice loss exceeds accumulation.

accumulation The process by which a glacier is replenished by snow and rain.

accumulation area The upper area on the glacier where accumulation of ice and snow exceeds the amount lost by ablation.

albedo The reflectivity of solar radiation of a surface.

alpine The elevational zone above treeline, dominated by rock, ice and snow.

ancient forest The last stage in forest succession. Also called old-growth forest.

avalanche A large mass of snow or ice that breaks off from a mountain slope and suddenly slides or falls downward. Glaciers are "fed" by snow avalanches.

basal slip The sliding action at the base of a glacier.

biodiversity The variety and variability of living organisms on three different levels – genetic, species, and ecosystem.

biomass The amount of living or once living material expressed in dry weight per unit area.

braided stream A stream flowing in several dividing and reuniting channels, resembling the strands of a braid.

canopy The upper level of forest vegetation which intercepts most sunlight, rain, and snow.

carnivore An animal that eats other animals; a meat eater.

cirque A large, bowl shaped depression in the landscape formed by glacial erosion.

climax forest The final and most stable stage in forest succession which remains relatively unchanged.

community A group of plants or animals living in the same habitat.

conifer A plant that bears its seeds in cones.

crevasse A deep crack in a glacier formed by glacial movement.

decomposer	A plant or animal that feeds on dead material and breaks it down.
density	Mass per unit volume.
dormant	A state of inactivity.
Douglas-fir	A coniferous member of the old-growth forest community. Douglas-firs can grow over 200 feet tall and 15 feet in diameter and live up to 1,200 years.
ecosystem	A community of organisms and its physical setting.
epiphyte	A plant that grows on other plants, but not as a parasite; an air plant.
equilibrium line	The boundary of the glacier separating the accumulation area from the ablation area.
erosion	The process by which the earth's surface is worn away by the action of water, glaciers, wind, etc.
extinction	The death of a species.
extirpation	Complete removal; extermination.
firn	A hard, compacted snow of rounded granules of ice, more dense than fresh snow, but less dense than ice. Also called neve.
fog drip	Fog condensing on needles of trees and dripping to the ground.
glacial advance	The forward movement of a glacier's terminus. The snout of an advancing glacier is convex.
glacial flour	Fine-grained sediment in glacial rivers formed by glacial erosion of the bedrock.
glacial polish	The smoothing of a rock by glacial flour carried on the underside of a glacier.
glacial retreat	The upvalley movement of a glacier's terminus. The snout of a retreating glacier is concave.
glacial striations	Scratches in the bedrock formed by the dragging of coarse rock material carried in the bed of a glacier.
glacier	A moving river of ice formed by the accumulation of snow over several years, compressing into ice, and moving downhill under its own weight.
habitat	The place where a plant or animal lives.
hanging valley	A tributary valley which has a floor higher than the larger main valley that it joins.
herbivore	An animal that eats plants; a vegetarian.
hypothermia	A systematic lowering of the body temperature below 95° F.
icefall	The steepest part of a glacier, usually heavily crevassed.

indicator species	Animal or plant species used to indicate special environmental factors, plant community types or successional stages.
insulation	A covering material used to reduce the transfer of heat, electricity, or sound.
jokulhlaup	An outburst of water suddenly released by a glacier (yo-kul-hloip).
lateral moraine	Accumulation of rock material on the sides of a glacier, derived from rockfalls and erosion of the valley sides by the glacier.
lichen	A plant that is a combination of a fungus and an alga.
life zones	Bands of vegetation resulting from the particular topography and climatic conditions; also called biotic zones.
marbled murrelet	A chunky, robin-sized seabird which nests in the old-growth forests of the Northwest.
moraine	Accumulation of rock material on or around a glacier, derived from rockfalls and from erosion of the valley sides by the glacier. Moraines can be lateral, terminal, or medial.
mycorrhizae	The symbiotic relationship of a fungus with the roots of plants. The fungus receives carbon compounds from the plant and the plant receives soil nutrients from the fungus.
Nisqually Glacier	The 7th largest glacier on Mount Rainier, 1.8 sq. miles in size. The primary source of the Nisqually River.
nitrogen fixing	The process by which some bacteria and algae convert atmospheric nitrogen into organic compounds for use by the host plant.
nurse log	A fallen tree that provides a place for seedlings to get established.
old-growth forest	A very old and complex forest community characterized by a variety of tree species, sizes and ages, as well as fallen and standing dead wood. Also called ancient forest.
omnivore	An animal that eats both plants and animals.
parasite	An animal or plant that lives on or in an organism of another species from which it obtains nutrients.
pine marten	A member of the carnivorous weasel family most abundant in mature and old-growth forests.
pioneer species	The first plant species to colonization an area.
plastic deformation	A permanent change in the shape of a solid related to the gliding and rotation of grains and recrystallization.
Pleistocene	The Great Ice Age which lasted from about 2 million years ago to 10,000 years ago.
plucking	The process by which glacial ice freezes to bedrock, then dislodges and picks up rock fragments as the glacier moves.

producer	A plant containing chlorophyll that produces food through the process of photosynthesis.
rainshadow	The effect of a mountain intercepting clouds causing them to drop their moisture on the windward slopes while the leeward side receives much less precipitation.
red tree vole	A highly specialized mammal that nests high in the canopy of mature Douglas-fir trees and feeds almost exclusively on Douglas-fir needles.
scavenger	An animal that eats the dead remains and wastes of plants and other animals.
snag	A standing dead tree which provides food and habitat for many creatures.
spotted owl	A threatened species that inhabits dense old-growth forests (considered an indicator species).
subalpine	The elevational zone lying between the continuous forest and the treeless alpine zone.
succession	The gradual replacement of one plant community by another.
tarn	A small mountain lake or pool, often formed in the bottom of a cirque after the ice has melted.
temperate	Moderate in respect to temperature; not subject to prolonged extremes of hot or cold weather.
terminal moraine	Accumulation of rock material at the terminus of a glacier, derived from the forward pushing of a glacier or dropped from the glacier's terminus.
terminus	The downvalley end of a glacier. Also called a snout.
transpiration	The process by which water evaporates from plants.
till	Unsorted rock debris deposited directly by the glacier.
trimline	The sharp boundaries of vegetation that delineates the upper margin of past glaciation.
understory	The layer of the forest made up mostly of shrubs and young trees found underneath the canopy layer.
velocity	Speed.
watershed	The entire land area drained by a stream or river.
western hemlock	The largest hemlock native to the United States; grows well in shade and is 125-175 feet tall and 4-6 feet in diameter.
western red cedar	A large tree preferring moist areas at elevations up to 4,000 feet. It grows 150-200 feet tall and 6-10 feet in diameter. It was widely used by the native people of the Pacific Northwest.

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Those marked with an asterisk * are available for purchase through the Northwest Interpretive Association, Mount Rainier National Park, Longmire, WA 98397 (360) 569-2211 ext. 3320. Selected items are also available at the park visitor centers.

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Biological Diversity, Makes a World of Difference, National Parks and Conservation Association, 1015 31st St. NW, 4th Floor, Washington, D.C., 20007.

Field Manual for Water Quality Monitoring, An Environmental Education Program for Schools, William Stapp and Mark Mitchell, 2050 Delaware Ave., Ann Arbor, MI 48103.

Forests of Washington: *Forest Ecosystems and People, Activity Guide Grades 4-9*, Environmental Education About Forests, 711 Capitol Way, Suite 608, Olympia, WA 98501, (360) 352-1500.

The Living Forest, A Curriculum Guide to the Lowland Forests of Olympic National Park, Northwest Interpretive Association, 83 South King Street, Suite 212, Seattle, WA 98104.

Living With Mountains, A Guide For Learning and Teaching About Mountain Landscapes, North Cascades Institute, 2105 Hwy 20, Sedro Woolley, WA 98284, (360) 856-5700.

Mountain PLAY (Packet for Learning About Your Mountain) , Theresa M. Carroll, Mount Rainier National Park, Ashford, WA 98304, (707) 528-4490.

NatureScope, National Wildlife Federation, 1412 Sixteenth St. NW, Washington, D.C. 20036-2266

N.I.C.H.E.S. (Northwest Integrated Concept/Process Hands-On Environmental Science) , Kelso School District #458, 601 Crawford Street, Kelso, WA 98626, (360) 577-2413.

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Project WET Idaho, Idaho Water Resources Research Institute, 106 Morrill Hall, University of Idaho, Moscow, ID 83843, (208) 885-6429.

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Maps, Films and Videos

Fire and Ice (20 min.)

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Summit to Sea (50 min.)

This KIRO television documentary records the 1991 celebrity climb of Mount Rainier organized to heighten public awareness of the Nisqually River basin, including its source on the slopes of Washington's highest mountain. It covers the human history of the park, natural history of the area, and land use in the Nisqually River basin. Available from the Nisqually River Basin Land Trust, P.O. Box 1148, Yelm, WA 98597.

**Mount Rainier, Reader's Digest Great National Parks* (35 min.)

Includes geology, glaciers, jokulhlaups, old-growth forests, weather, wildlife, history and mountain climbing. Beautiful photography. Pleasantville, NY, Reader's Digest, 1992.

Nisqually Glacier USGS Map (1976)

These 19 x 42" maps are available either folded (#WA756) or unfolded (#WA757) and cost $2.50 each. USGS Map Sales, P.O. Box 25286, Denver, CO 80225. (303) 236-7477.